AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE	OF	PAGES
	1		3

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. *(If applicable)*
0001	11 APR 01		

6. ISSUED BY	CODE	7. ADMINISTERED BY *(If other than Item 6)*	CODE
US ARMY ENGINEER DISTRICT, FORT WORTH ATTN: CESWF-CT (RM 2A19) PO BOX 17300 FORT WORTH, TX 76102-0300			

8. NAME AND ADDRESS OF CONTRACTOR *(No., street, county, State and ZIP Code)*	(X)	9A. AMENDMENT OF SOLICIATION NO.
	☒	DACA63-01-B-0003
		9B. DATED *(SEE ITEM 11)* 26 MARCH 2001
	☐	10A. MODIFICATION OF CONTRACT/ORDER NO.
		10B. DATED *(SEE ITEM 11)*

CODE	FACILITY CODE

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☒ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☒ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:

(a)By completing items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment your desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*

13. THIS ITEM ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

CHECK ONE	
	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation date, etc.)* SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
	D. OTHER *(Specify type of modification and authority)*

E. IMPORTANT: Contractor ☐ is not, ☐ is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (*Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

The Solicitation for RAILHEAD, PHASE III, PN 20276, FORT HOOD, TEXAS, is amended as follows:

See Continuation Sheets.

NOTE: The bid opening date and time remains "1400 local time 25 April 2001," as previously announced.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER *(Type or print)*		16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)*	
15B. CONTRACTOR/OFFEROR *(Signature of person authorized to sign)*	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA *(Signature of Contracting Officer)*	16C. DATE SIGNED

Item 14. Continued.

CHANGES TO THE SPECIFICATIONS.

1) Replacement Sections - Replace the following sections with the accompanying new sections of the same number and title, bearing the notation "ACCOMPANYING AMENDMENT NO. 0001 TO SOLICITATION NO. DACA63-01-B-0003."

SECTION 01420 BASIC POLLUTION PREVENTION PLAN FOR RAILHEAD, PHASE III, FORT HOOD, TEXAS
SECTION 02300 EARTHWORK
SECTION 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS
SECTION 02556 ASPHALTIC BITUMINOUS HEAVY-DUTY PAVEMENT (CENTRAL-PLANT HOT MIX)
SECTION 02721 SUBBASE COURSES
SECTION 02722 AGGREGATE BASE COURSE
SECTION 02731 AGGREGATE SURFACE COURSE
SECTION 02741 BITUMINOUS PAVING FOR ROADS, STREETS AND OPEN STORAGE AREAS
SECTION 02753 CONCRETE PAVEMENT FOR HEAVY-DUTY PAVEMENTS
SECTION 02770 CONCRETE SIDEWALKS AND CURBS AND GUTTERS
SECTION 03405 PRESTRESSED CONCRETE BRIDGE GIRDERS - RAILROAD BRIDGE
SECTION 05325 HANDRAILS - RAILROAD BRIDGE
SECTION 05650 RAILROADS
SECTION 09915 COLOR SCHEDULE
SECTION 14601 CRANE, GANTRY, TOP RUNNING, 4-TON MAXIMUM CAPACITY

CHANGES TO THE DRAWINGS.

1) New Drawings.- Add the following new drawings listed below to the solicitation, each bearing the notation "AM #0001".

C510_1.cal Seq 238A C5-10 DRRF FACILITY - OVERALL PLAN - SANITARY SEWER (Base Bid)
C511_1.cal Seq 238B C5-11 DRRF FACILITY - SANITARY SEWER PLAN & PROFILE 1
C512_1.cal Seq 238C C5-12 DRRF FACILITY - SANITARY SEWER PLAN & PROFILE 2
C513_1.cal Seq 238D C5-13 DRRF FACILITY - SANITARY SEWER PLAN & PROFILE 3
C514_1.cal Seq 238E C5-14 DRRF FACILITY - SANITARY SEWER PLAN & PROFILE 4
E1001_1.cal Seq 304 E10.01 LIGHTNING PROTECTION PLAN, NORTH
E1002_1.cal Seq 305 E10.02 LIGHTNING PROTECTION PLAN, SOUTH
E1003_1.cal Seq 306 E10.03 LIGHTNING PROTECTION, POLE DETAILS I
E1004_1.cal Seq 307 E10.04 LIGHTNING PROTECTION, POLE DETAILS II

2) Replacement Drawings.- Replace the drawings listed below with the attached new drawings of the same number, bearing the notation "AM #0001":

C49_1.cal Seq 49 C49 TYPICAL PAVING SECTIONS 1
E02_1.cal Seq 130 E2 EXTERIOR ELECTRICAL LEGEND & SCHEDULES
E04_1.cal Seq 132 E4 EXTERIOR ELECTRICAL PLAN, AREA "2"
E07_1.cal Seq 135 E7 EXTERIOR ELECTRICAL PLAN, AREA "5"
E08_1.cal Seq 136 E8 EXTERIOR ELECTRICAL PLAN, AREA "6"
E09_1.cal Seq 137 E9 EXTERIOR ELECTRICAL PLAN, AREA "7"
E10_1.cal Seq 138 E10 EXTERIOR ELECTRICAL PLAN, AREA "8"
E11_1.cal Seq 139 E11 EXTERIOR ELECTRICAL PLAN, AREA "9"

E17_1.cal Seq 145 E17 EXTERIOR ELECTRICAL DETAILS, SHEET IV
E21_1.cal Seq 149 E21 POLE DETAILS, SHEET II
E25_1.cal Seq 153 E25 EXTERIOR ELECTRICAL ONE-LINE DIAGRAM
E29_1.cal Seq 157 E29 BID OPTION #6 - RELOCATE SCALE HOUSE
E32_1.cal Seq 160 E32 BID OPTION #9 - POV PARKING NEAR DRRF
G-4_1.cal Seq 00 G-4 INDEX VOLUME TWO
M203_1.cal Seq 185 M2.03 HVAC PLAN
M210_1.cal Seq 192 M2.10 PLUMBING DETAILS
E204_1.cal Seq 198 E2.04 POWER & FIRE ALARM RISERS AND POWER PANEL SCHEDULES
C501_1.cal Seq 230 C5-01 DRRF FACILITY - LAYOUT AND GRADING PLAN
C502_1.cal Seq 231 C5-02 DRRF FACILITY - UTILITY PLAN 1
C508_1.cal Seq 237 C5-08 DRRF FACILITY - UTILITY DETAILS 2
M502_1.cal Seq 259 M5.02 MECHANICAL SCHEDULES
E502_1.cal Seq 266 E5.02 ELECTRICAL EXTERIOR SITE PLAN, SHEET II
E503_1.cal Seq 267 E5.03 ELECTRICAL EXTERIOR SITE PLAN, SHEET III
E505_1.cal Seq 269 E5.05 INTERIOR LEGEND, INTERIOR DETAILS, & ROOM SCHEDULE
E509_1.cal Seq 273 E5.09 POWER AND FIRE ALARM RISERS, DIAGRAMS, & PANEL SCHEDULES
E801_1.cal Seq 300 E8.01 BID OPTION #3 - LUMBER YARD EXTERIOR ELECTRICAL PLAN
E802_1.cal Seq 301 E8.02 BID OPTION #3 - LUMBER YARD POLE DETAILS & DIAGRAM
E803_1.cal Seq 302 E8.03 BID OPTION #3 - INTERIOR LEGEND, PLANS, & DIAGRAM
S901_1.cal Seq 303 S9.01 FOUNDATION & SECTIONS

3) Deleted Drawings.- Delete the following drawings from the solicitation.

C503_1.cal Seq 232 C5-03 DRRF FACILITY - UTILITY PLAN 2
C504_1.cal Seq 233 C5-04 DRRF FACILITY - UTILITY PLAN 3
C509_1.cal Seq 238 C5-09 DRRF FACILITY - LIFT STATION DETAILS

END OF AMENDMENT

SECTION 01420

BASIC POLLUTION PREVENTION PLAN
FOR
RAILHEAD, PHASE III
PN 20276
FORT HOOD, TEXAS
Amendment No.1

1.0 SUMMARY

1.1 PROJECT DESCRIPTION

This project is designed to support the Army's mobilization and deployment mission by constructing a rail loading facility augmenting the existing railhead in the main cantonment area at Fort Hood, Texas. This action is accomplished through two phases of construction. The Phase I construction was awarded in FY 1999. The Phase III construction is anticipated to be awarded in June, 2001.

There are two site locations involved in Phase III construction. A major part of the support facilities to be constructed in Phase III are east of the railhead facility (or railroad loading yard in Phase I). It includes a Wye Track (approximately 1,300 meters) and a Connector Track and bridge (approximately 3,575 meters). This rail system in Phase III construction will connect the railroad loading facility to the existing Burlington Northern & Santa Fe rail system. Other features to enhance the rail loading function includes construction of a Container Loading and Storage area, a Control Tower, an Engine Maintenance Facility, a Division Readiness Reaction Field (DRRF) Administration Facility, Vehicle Wash Facility, Scale House (for Vehicle Scales installed in Phase I), and a Vehicle Staging Area.

The Division Readiness Reaction Field (DRRF) administration facility shall be located northeast of the railroad loading yard.

The utilities required for support of these facilities shall include electric, water, sewer, and gas services. The distribution piping for utilities are installed as a part of Phase I construction. Phase III work requires connecting new buildings to the in-place utilities. The storm drainage features in the project include pipe culverts and concrete headwalls, curb inlets, low point surface inlets, manhole, interceptor trench and ditches. Security and safety features shall include railroad lighting and signals. Other support features are paved hardstand and parking areas, sidewalks, curbs and gutters.

The Phase III construction includes approximately 17 hectares and all of which shall be disturbed at one time or another due to construction operations. Phase III construction includes:

Engineering Maintenance Facility – 0.4 hectares

Vehicle Wash Facility – 0.16 hectares

Vehicle Staging Area and Scale House for Vehicles – 0.20 hectares

Container Storage and Loading Area – 1.53 hectares

Control Tower – 0.003 hectares

DRRF Facility – 0.12 hectares

Wye Track – 2.48 hectares

Connector Track – 12.15 hectares

1.2. STANDARD INDUSTRIAL CLASSIFICATION (SIC) CODES

The construction activities associated with this project have the following SIC codes in accordance with the Standard Industrial Classification Manual published by the Office of Management and Budget (OMB):

a. 1629 – Heavy Construction, Not Elsewhere Classified (i.e. athletic fields, bridle paths, canal construction, clearing and grubbing, cofferdams, dikes, boat docks, drainage projects, flood control projects, levees, pond construction, railroads, reservoirs, sewage treatment plants, water treatment plants)

b. 1541 – General Contractors – Industrial Buildings and Warehouses

c. 1771 – Concrete Work (includes asphalt, i.e. access drives and parking lots, culvert construction)

d. 9711 – National Security (a general category for military facilities)

1.3 LOCATION

This project shall be constructed at two different locations. One location is in proximity to the railhead facility in Coryell County. This location includes Vehicle Wash Facility, Scale House, Vehicle Staging Area, Container Loading and Storage area, Control Tower, and Engine Maintenance Facility. This area is north of Hwy 190 approximately 4 miles east of Copperas Cove at the extreme west of Fort Hood. The latitude and longitude of the first site is 31° 07' **[Am # 1] 57"** north and 97° **[Am #1] __ 52' 31"** west respectively, and is bordered by Logistics Avenue to the east, Tank Destroyer Road to the north, and the railroad tracks to the south.

The other location is the Division Readiness Reaction Field (DRRF) Administration Facility. It is located on North Avenue on the main base four miles northeast of the first site at latitude 31° 09' north and longitude 97° 46' west. The facility is located approximately 525 meters west of the intersection of North Avenue and 53rd Street.

1.4 RECEIVING WATERS

The proposed sites for Phase III construction are generally unimproved areas and are located on the Brazos River watershed. All storm water received on the construction sites will collect into tributaries draining into Clear Creek that ultimately flows into Cowhouse Creek. Cowhouse Creek is a main tributary flowing into Belton Lake. The Belton Lake was constructed on the Leon River that ultimately flows into the Brazos River.

2.0 SITE DESCRIPTION

2.1 EXISTING CONDITIONS

The proposed site for construction of the railroad loading yard support facilities is located in the extreme west Fort Hood and is in an unimproved area consisting of brushy vegetation. The area slopes generally towards the south and east at a rate of 3.5 percent. Runoff sheet flows into small draws that make up the headwaters of Clear Creek. The normal annual precipitation for the area is 780 mm. The runoff coefficient for the area is 0.3. This is based on an unimproved area that consists of a black or loessial soil with a slope ranging from 3 percent to 5 percent. The velocity of storm water across the site is approximately 0.4 meters/second.

2.2 FUTURE CONDITIONS

The areas around the support facilities shall be graded away from the building at a minimum slope of 5 percent (5) for the first 3 meters. The maximum fill slopes shall be roughly 33 % and the maximum cut slopes shall be roughly 50 %. The Container Loading and Storage areas shall have a cross slope of roughly 1 % to the south. Upon completion of the project, storm water shall be directed by means of low point surface inlets and

subsurface drains into drainage swales via culverts that ultimately lead into the Clear Creek. Other drainage features shall include interceptor trenches, interceptor ditches along the railroad tracks to divert drainage from the steep cut slopes, and pipe culverts with concrete headwalls at natural drainage crossings. Runoff from building sites shall sheet flow to existing ditches or new culverts that ultimately lead into the Clear Creek. Although the final graded slope is less than the original slopes, the hardstand areas shall increase the runoff coefficient to 0.75.

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2.3 CONSTRUCTION PHASING

The Phase III construction activities are expected to begin in August 2001. The anticipated length of this contract is 12 months.

Since there are bid options in this contract, the Contractor's Detailed SWPPP shall reference the bid document to update the executed base bid and optional work and subsequent construction phasing activities. The following major construction activities are anticipated for this project:

A. Mobilization of Contractor and establishing storm water pollution prevention control structures.

B. Clearing and Grubbing – The limit of clearing and grubbing will be the same as the approximate limit of grading shown on the civil drawings.

C. Construction Phasing – The Contractor shall determine the Base Bid and Bid options for Phase III construction and discussed phasing requirements as deemed necessary to execute work in this paragraph.

D. Grading and Drainage – Runoff from all areas shall sheet flow to existing ditches or new culverts. Storm culverts shall establish along the new tracks at creek crossings. Surface inlets shall be constructed to divert runoff to subsurface drainage and then to culverts and existing ditches. Cut and fill slopes shall be 1V: 3H throughout the project.

E. Site Stabilization – All disturbed sites shall be stabilized temporarily and permanently in accordance with paragraph 3.0, EROSION AND SEDIMENT CONTROLS.

F. Removal of storm water control structures shall require approval of Contracting Officer Representative.

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2.4 SOIL DATA

The following soil information is from the Soil Survey of Coryell County, Texas, issued May 1985 by the United States Department of Agriculture, Soil Conservation Service. This is in cooperation with the Texas Agricultural Experimental Station and the United States Department of the Army, Fort Hood, Texas. The site is located on soils mapped as Nuff-Cho association. The predominate soils on this site are characterized as nearly level to sloping; very shallow to moderately deep; dark clay, sandy, gravelly soils over limestone. Permeability is moderate to moderately slow, in the upper layers; however, it is slow in the caliche layers. Water capacity tends to range from low to high, depending on the incidence of rock. Runoff is medium and the hazard of erosion is moderate. Shrink-swell potential ranges from low to moderate. Soil reaction tends to be moderately alkaline (pH = 7.9 – 8.4) and the root zone tends to be relatively shallow and rocky, which can hinder the establishment of grasses. Unified classification of the surface layer is CL and CH, and the subsoil is CL, CH, SM-SC, SC, GC, and GM-GC.

2.5 DRAWINGS

The attached drawings to the basic SWPPP provide details for the layout and construction of storm water control structures required to alleviate erosion potential during the construction phase of this project. The SWPPP drawings are listed at the end of this section.

3.0 EROSION AND SEDIMENT CONTROLS

3.1 TEMPORARY STABILIZATION

During periods when establishment of turf is not contractually approved, all unpaved, graded, and disturbed portions of the site where construction activity temporarily ceases for at least 21 days will be stabilized with a hay mulch no later than 14 days from the last construction activity in that area. Before mulching, 340 kilograms of a 15-5-10 fertilizer shall be applied to each hectare to be stabilized. After fertilizing and tilling, each area shall be mulched with hay at the rate of 3.18 metric tons per hectare. The hay mulch is to be anchored into place by a mulch-anchoring machine equivalent to a disk harrow with cupped disks removed and replaced with straight rolling coulters spaced not more than 250 mm apart. Tillage shall be 100 mm.

3.2 PERMANENT STABILIZATION

During periods when establishment of turf is contractually approved, disturbed portions of the site where construction activities permanently cease will be stabilized within 14 days after the last construction activity. Grass seed will be applied according to Section 02933 – SEEDING MIXTURE. Maintenance will consist of watering, refertilizing, mowing, and repair of erosion damage.

3.3 TEMPORARY SEDIMENT BASINS

Subsurface drainage features are required for this project and shall be implemented early during construction to keep the area well drained. The majority of the disturbed area involved in this project shall be for the railroad yard. It is economically more feasible to protect the subsurface drainage by use of surface inlet protection and prevent silt from entering the drainage system than to dedicate additional acreage for the use of a sediment basin. Construction right of way is necessarily limited due to the presence of existing railroad track owned by private companies. Sediment basins are not recommended for use in these areas because there is not adequate space for construction. Other structural controls such as ditch checks and sediment traps will be utilized to manage storm water during construction of the railroad tracks.

3.4 STRUCTURAL CONTROLS

The Contractor shall use silt fences, check dams, and other appropriate type of structural controls necessary to prevent soil erosion at the construction site. In general, storm controls shall be used along the perimeter of grading, at each new and existing storm inlets and culverts and the drainage swales. Erosion and sediment control details are depicted on Sheet H23 of the contract plans and specifications.

3.4.1 SILT FENCE

Silt fences shall consist of geotextile fabric supported by poultry netting or other backing stretched between either wooden or metal posts with the lower edge of the fabric securely embedded in the soil. The fence is typically located downstream of disturbed areas to intercept runoff from sheet flow. A silt fence provides both filtration and time for sedimentation to reduce sediment and it reduces the velocity of the runoff. A properly designed silt fence is economical since it can be relocated during construction and reused.

Silt fences are normally used as perimeter controls located downstream of disturbed areas. It is only feasible for non-concentrated, sheet flow conditions.

Silt fences are used as perimeter control devices for both site developments and linear type projects. They are most effective with coarse to silty soil types. Due to the potential of clogging, silt fence shall not be used with clay soil types.

3.4.2 CHECK DAM

Check dams are small barriers consisting of straw bales, rock, or earth berms placed across a drainage swale or

ditch. They reduce the velocity of small concentrated flows, provide a limited barrier for sediment and help disperse concentrated flows, reducing potential erosion.

Check dams are used for long drainage swales or ditches where permanent vegetation is not established and erosive conditions are present. They are typically used in conjunction with other techniques such as inlet protection, riprap or other sediment reduction techniques. Check dams provide limited treatment. They are more useful in reducing flow to acceptable levels for other techniques.

Check dams are typically used early in construction in swales for long linear project such as railroad tracks. They can also be used in short swales with a steep slope to reduce unacceptable velocities. Check dams should be placed at a distance and height to allow small pools to form between each one. Typically, dam height should be between 0.5 to 1.0 meter. Dams should be spaced such that the tip of the downstream dam should be at the same elevation as the toe of the upstream dam.

3.4.3 DIVERSION DIKE

A diversion dike is a compacted soil mound that redirects runoff to a desired location. The dike is typically stabilized with natural grass for low velocities or with stone or erosion control mates for higher velocities.

The diversion dike is normally used to intercept off site flow upstream of the construction area and direct the flow around the disturbed soils. It can also be used downstream of the construction area to direct flow into a sediment reduction device such as a protected inlet or a stone outlet sediment trap. The diversion dike serves the same purpose and, based on the topography of the site, it is used in combination with an interceptor swale. The maximum contributing drainage area should be 4 hectares or less depending on site conditions.

3.4.4 PIPE SLOPE DRAIN

A pipe slope drain is a temporary pipeline typically using flexible pipe that conveys runoff down unprotected slopes. The drain is anchored on the upstream end with some form of headwall to limit erosion and secure the pipe.

A pipe slope drain is used on site with a long, steep slope area that is subject to erosion from overland flow. It is normally used in combination with interceptor swales or diversion dikes to direct the flow into the pipe area.

Sites such as this railhead project that have numerous unprotected slopes from cut areas, pipe slope drains shall be provided. Some provisions shall have to be made to direct the flow into the pipe drain, normally by grading upstream. The pipe slope drains for this project shall require a stabilized outlet. Velocity dissipaters, as well as stone or concrete riprap, are typically required to reduce the velocity and spread the flow.

3.4.5 STONE OUTLET SEDIMENT TRAP

A stone outlet sediment trap is a small ponding area formed by placing a stone embankment or gabion core with an integral stone filter outlet across a drainage swale for detaining sediment-laden runoff generated by construction activities. The sediment trap detains runoff long enough to allow most of the suspended sediment to settle while still allowing for diffused flow of runoff.

A sediment trap is required in this project immediately upstream of storm water culverts and where flows are concentrated in a drainage swale or channel. The sediment traps are designed to reduce velocity and allow for settling of sediment while allowing the area behind the trap to de-water. Sediment traps shall be used instead of sediment basins for this project. The use of a rock or gabion core as opposed to a compacted earth core shall provide additional filtration and shall aid in dewatering the area further.

3.4.6 SURFACE OR CURB INLET PROTECTION

Inlet protection consists of a variety of methods of intercepting sediment at low point inlets using stone, filter fabric and other materials. This material is normally located at the inlet, providing either detention or filtration to reduce sediment and floatable materials in storm water.

Inlet protection is only viable at low point inlets. Inlets that are on a slope cannot be effectively protected because storm water shall bypass the inlet and continue downstream. No inlets constructed on slopes are anticipated for this project and all inlets shall be low point inlets. Inspections shall be made on a weekly basis, especially after large storm events. When silt fence is used and the fabric becomes clogged, it shall be cleaned or if necessary, replaced. In addition, sediment shall be removed when it reaches approximately one-half the height of the fence. If a sump is used, sediment shall be removed when the volume of the basin is reduced by 50 %. For systems using stone filters, when the stone filter becomes clogged with sediment, the stones shall be pulled away from the inlet and cleaned or replaced. Since cleaning of gravel at a construction site is difficult, an alternative approach shall be used the clogged stone as fill material and put new stone around the inlet.

Curb inlet locations are not shown on the Erosion and Sediment Control Plan. The Contractor shall use these storm control structures at new or existing curb inlets during construction of facilities

3.4.7 STABILIZED CONSTRUCTION ENTRANCE

A stabilized construction entrance consists of a pad consisting of gravel, crushed stone, recycled concrete or other rock like material on top of geotextile filter cloth to facilitate the wash down and removal of sediment and other debris from construction equipment prior to exiting the construction site.

Stabilized construction entrances are used primarily for sites in which significant truck traffic occurs on a daily basis. It reduces the need to remove sediment from streets. Stabilized construction entrances are to be constructed such that drainage across the entrance is directed to a controlled, stabilized outlet on site with provisions for storage proper filtration and removal of wash water. The entrance shall be properly grades so that storm water is not allowed to leave the site and enter roadways. The minimum width of the entrance shall be 4.5 meters, but in no case shall the width be less than that of the entryway to be used. Finally, the minimum depth of entrance shall be 205 mm.

4.0 STORM WATER MANAGEMENT CONTROLS.

During construction of the project, the duration and quantity of storm water runoff is anticipated to decrease due to initial ground conditions at the site. The existing site has a runoff coefficient of 0.3 percent and a steep slope ranging from 2.2 percent to 3.4 percent. After completion of the project, runoff shall increase because of the new parking areas and hardstand. The runoff coefficient shall increase to 0.75 for the area and the graded shall have a more gradual slope. The railroad track shall be constructed in a cut section. The maximum fill slopes is roughly 33 % and the maximum cut slopes is roughly 50 %. The cut slopes along the railroad track shall be established by turfing and storm water falling on these slopes shall be directed into interceptor trenches and ditches draining into the headwaters of Clear creek.

The following storm water management controls shall be included as permanent features upon completion of this project. All features were designed considering the 10-year storm frequency for Coryell County and use of the rational method.

4.1 STORM DRAINAGE SYSTEM

The surface inlets shall be constructed to drain the area between the two railroad yards. The inlets are designed as low point inlets and shall be located between the track sections as indicated on the drawings. The surface inlets shall be constructed of concrete and have an opening of 510 mm to capture storm water drainage. The inlets shall have a standard metal grate to catch trash, vegetation, and rubbish. Storm water

shall be collected in 600-mm pipes and taken to drainage swales around the railroad yards. The surface inlets are designed to withstand normal traffic loading.

In the hardstand area located near the railroad-loading yard in Phase I construction, storm water drains towards the east end of the area and is directed to drop chutes by the use of curb and gutter. The drop chutes are designed to dissipate outfall velocity before releasing the water off the site.

4.2 DRAINAGE SWALES AND DITCHES

Drainage swales and ditches shall be utilized as a permanent feature to control storm water for this project. These ditches are designed for a ten (10) year storm event. Along the railroad track, The interceptor trenches and ditches shall have 1V:3H side slopes constructed. The side slopes and bottom of the swales shall be established by turfing.

4.3 DRAINAGE CULVERTS

There are pipe culverts to be constructed along the railroad track to the south of the railroad yards. These culverts shall range from 300 mm to 1500 mm in diameter. The culverts shall be either single or multiple pipe culverts.

The culverts are located on mild slopes and the hydraulic control shall be at the culvert outlet. An entrance loss coefficient for a concrete square edge headwall is assumed to be 0.5. In addition, calculations were modified for several of the culverts that are considered long spans culverts. The length of the culverts is due to the culverts crossing underneath the railroad tracks. Outlet velocities were designed to range from 1.5 to 2.1 meters/second. Concrete headwalls shall be utilized on both the upstream and downstream sides of the culvert.

5.0 BEST MANAGEMENT PRACTICE DURING CONSTRUCTION

The construction Contractor or its subcontractors shall be responsible for minimizing erosion and controlling sediment in storm runoff. Contractor shall address Best Management Practices (BMPS) to prevent storm water pollution.

5.1 WASTE MATERIALS.

Solid waste materials (trash and construction debris) shall be placed in appropriate waste containers and covered. Waste containers shall be emptied regularly; they shall not be allowed to overflow. The disposal area of excavated materials from project construction shall not be utilized for waste disposal. Routine janitorial service shall be provided for all construction buildings and surrounding grounds. No construction waste materials, including concrete, shall be buried or otherwise disposed on-site. All site personnel shall be briefed on the correct procedures for solid waste disposal.

5.2 HAZARDOUS WASTE.

All hazardous waste shall be handled, stored, and disposed in accordance with all Federal, State, and local regulations and before all other construction activities. Chemical waste shall be stored in clearly labeled, corrosion-resistant containers, and stored in designated areas before removal from the site. Materials more than job requirements shall not be stored on-site. All site personnel shall be briefed on the correct procedures for hazardous waste disposal.

5.3 SANITARY WASTE.

On-site sanitary facilities shall be established. Facility location, design, maintenance, and waste collection practices shall be in accordance with local regulations.

5.4 OFF-SITE VEHICLE TRACKING

Every effort shall be made to keep vehicles from tracking soils from the construction site, access points, material borrow, and disposal areas. The Contractor shall identify stabilized construction entrances to each construction site, on-site and off-site borrow and disposal areas, and the types of control structures on the SWPPP drawings. The contractor shall have a detail or specified material of construction for the Contractor's staging and temporary parking area on the SWPPP. Dust generation shall be controlled by sprinkling, chemical treatment, light bituminous treatment, or similar methods. Materials hauled from the construction site in open-bed vehicles shall be covered or otherwise stabilized to avoid their loss during transport.

5.5 CONSTRUCTION VEHICLE MAINTENANCE AND REPAIR.

Specific areas shall be designated for equipment maintenance and repair to minimize potential impact on storm water runoff. All construction vehicles shall be regularly inspected for leaks and receive regularly scheduled maintenance to reduce the potential for leaks.

5.6 FERTILIZERS.

If fertilizers are used, they shall be applied in accordance with the specifications, i.e. in the stated amounts and only when weather conditions are appropriate.

5.7 VEHICLE FUELING.

Vehicle fueling at project site shall be conducted in accordance with good safety practices to reduce the potential for leaks and spills. Only properly constructed fuel containers shall be used on site and shall be labeled and stored in accordance with applicable codes. Washing and curing waters shall be drained into a retention basin constructed by the Contractor and are to be cleaned up by the Contractor to the satisfaction of the Contracting Officer Representative after project completion.

6.0 TIMING OF CONTROLS AND ACTIVITIES.

Temporary and permanent stabilization shall be established in accordance with paragraph 3.0 EROSION AND SEDIMENT CONTROLS. When construction temporarily ceases, erosion control shall be established in accordance with paragraph 3.1, TEMPORARY STABILIZATION. The Contractor shall identify the detail sequence and control activities of the construction process.

7.0 COMPLIANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS

This project complies with the National Environmental Policy Act of 1969. The preliminary assessment screening was prepared for the Phase I work in August 1998. The Phase III is continuation of the unfinished construction activities in Phase I. The proposed site was disturbed previously by construction of the existing railroad system, construction work of the Directorate of Logistics, and military training activities. The proposed action does not present a hazard to the environment. No known hazardous materials have been stored in the surrounding area. No sign of site contamination was observed during visits conducted by the representatives of the DPW- Environmental. The proposed site is not in a threatened and endangered habitat area. **[Am #1] _____.** Additionally, review procedures for historic and archeological sites have been implemented for this project in accordance with 36 CFR 800. The review has established that there will be no impact to archeological sites.

The Record of Environmental Consideration (REC) signed in August 1998 stated the proposed action is qualified for Categorical Exclusion A-7, Appendix A, AR 200-2. **[Am #1]** **The project has been reviewed in accordance with Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. The project would not involve activities subject to Section 10; however, the project would involve activities subject to requirements of Section 404. In accordance with Section 404, the project as designed is in compliance with the terms and conditions of nation-wide permit 25, Structural Discharge.**

In accordance with AR 200 – 1, all Department of Defense installations and their construction contractors are required to comply with Federal environmental protection statutes, which include a provision to observe local environmental regulations. The Contractor shall comply with Texas Administrative Code (TAC), county, and local applicable environmental regulations.

8.0 MAINTENANCE AND INSPECTION PROCEDURES

The Contractor's quality control organization shall inspect all pollution prevention measures at least once every seven (7) days and within twenty-four (24) hours following any storm producing 13 millimeters or more of rainfall. The inspector shall thoroughly understand the requirements of the Contractor's SWPPP and shall have a basic knowledge of the engineering principles for reducing runoff pollution.

Temporary grading shall be inspected for erosion and soil loss from the site. Temporary erosion control measures shall be inspected for bare spots and washouts. The inspector shall inspect discharge points for signs of erosion or sediment. Locations where vehicles enter and leave the site shall be checked for signs of off-site sediment tracking. These locations shall include erosion control at material borrow and disposal areas. The Contractor shall review best Management Practices and pollution control maintenance procedures for adequate erosion control during project execution. All deficiencies shall be noted in the inspection reports and submitted to the Contracting Officer Representative after each inspection. Corrections to these problems shall be implemented within seven (7) calendar days. The Contractor shall comply with the NPDES permit requirements to prepare the INSPECTION and MAINTENANCE REPORT after each inspection event. These reports shall be posted on the project bulletin board and kept in the project file on site. The SWPPP shall be revised as necessary. After final stabilization has been achieved, the Contractor shall inspect the site once a month until final inspection and project acceptance by the Contracting Officer Representative.

9.0 MATERIAL INVENTORY

If concrete, paints, sealant, petroleum-based products, cleaning solvents, fertilizers, tar, asphalt, and steel reinforcing bars are present on site during construction, a copy with the list of materials and the respective material safety data sheets (MSDS) shall be included with the Contractor's detailed SWPPP.

10.0 NON-STORM WATER DISCHARGES.

Non-storm water discharge shall not be allowed during construction of the project except for emergency fire-fighting flows and other flows permitted in accordance with 63 FR 128, July 6, 1998 as referenced in paragraph, COMPLIANCE WITH FEDERAL, STATE, AND LOCAL REGULATIONS. In addition, any spill of a hazardous substance or oil more than reporting quantities shall be reported as required per 40 CFR 110.

11.0 CONTRACTOR COMPLIANCE.

The Contractor shall use this basic SWPPP to prepare a detailed SWPPP. This detailed SWPPP shall include both the narrative and the revised drawings. The detailed SWPPP shall state the following as a minimum: (1) the project start and completion dates, (2) base bid and bid options to be executed with the project, (3) sequence of construction activities and pollution control measures, (4) discussion of the Best Management Practices (BMP) and implementation of BMP during project execution, (5) identify the list of materials brought on – site including the MSDS, (6) runoff computation of each drainage area (see paragraph 4.1), (7) identify the locations and types of storm control structures on the revised storm water control plans, including curb inlets stabilized construction entrance, borrow and disposal sites .

Being responsible for the daily operations at the construction site, the Contractor shall submit the detailed SWPPP (including the revised storm water control plans), and a Notice of Intent (NOI) for the storm water discharges associated with Industrial Activity under NPDES General Permit to EPA Region 6 in Dallas, Texas. The NOI (EPA Form 3510-6) shall be submitted no later than 48 hours before start of construction. A separate NOI is required for each construction contract.

The Contractor's detailed SWPPP (including the revised storm water control plans) and a copy of submitted NOI shall be provided to the Contracting Officer before start of construction. A copy of the U.S. Army Corps of Engineers NOI (obtained from the Contracting Officer), the Contractor's NOI, and a brief project description shall be posted on the project bulletin board. The Contractor's detailed SWPPP shall be kept on-site at all times. During construction, the Contractor shall perform work as required per paragraph, MAINTENANCE AND INSPECTION PROCEDURES in this section.

No later than 10 working days after final stabilization, the Contractor shall submit the Notice of Termination (NOT), EPA Form 3510 – 7 to EPA. Two copies of the submitted NOT shall be provided to the contracting Officer's project file. EPA Forms are available on web site at http://www.epa.gov/earth1r6/6en/w/forms.htm

OWNER CERTIFICATION FOR
RAILHEAD FACILITY, PHASE III
PN 20276
FORT HOOD, TEXAS

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who managed the system, or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Michael J. Mocek, P.E.
Deputy District Engineer

Date Certified:

Attachments:

C1	Project Location Map 1
C2	Project Location Map 2
Sht H1	Container Loading and Storage Areas Erosion and Sediment Control Plan 1
Sht H2	Container Loading, Storage Areas, Control Tower, Engine Maint. Fac. Erosion and Sediment Control Plan 2
Sht H3	Wye Track Erosion and Sediment Control Plan 3
Sht H4	Wye Track Erosion and Sediment Control Plan 4
Sht H5	Wye Track Erosion and Sediment Control Plan 5
Sht H6	Wye Track Erosion and Sediment Control Plan 6
Sht H7	Wye Track Erosion and Sediment Control Plan 7
Sht H8	Vehicle Staging Area and Scale House Erosion and Sediment Control Plan 8
Sht H9	Vehicle Wash Facility Erosion and Sediment Control Plan 9
Sht H10	Connector Track Sta. 0+00 to 0+75 Erosion and Sediment Control Plan 10
Sht H11	Connector Track Sta. 0+75 to 4+25 Erosion and Sediment Control Plan 11
Sht H12	Connector Track Sta. 4+25 to 7+25 Erosion and Sediment Control Plan 12
Sht H13	Connector Track Sta. 7+25 to 11+25 Erosion and Sediment Control Plan 13
Sht H14	Connector Track Sta. 11+25 to 14+75 Erosion and Sediment Control Plan 14
Sht H15	Connector Track Sta. 14+25 to 18+25 Erosion and Sediment Control Plan 15
Sht H16	Connector Track Sta. 18+25 to 21+25 Erosion and Sediment Control Plan 16
Sht H17	Connector Track Sta. 21+25 to 25+25 Erosion and Sediment Control Plan 17
Sht H18	Connector Track Sta. 25+25 to 28+25 Erosion and Sediment Control Plan 18
Sht H19	Connector Track Sta. 28+25 to 32+25 Erosion and Sediment Control Plan 19
Sht H20	Connector Track Sta. 32+25 to 35+75 Erosion and Sediment Control Plan 20
Sht H21	Connector Track Sta. 35+75 to End Erosion and Sediment Control Plan 21
Sht H22	DRRF Facility Erosion and Sediment Control Plan 22
Sht H23	Erosion and Sediment Control Structural Details

SECTION 02300

EARTHWORK
12/97
Amendment #0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	(1996) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1140	(1992) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 2937	(1994) Density of Soil in Place by the Drive-Cylinder Method
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4318	(1995a) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.2 DEFINITIONS

1.2.1 Satisfactory Materials

Satisfactory materials shall comprise any materials classified by ASTM D

2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM,SC,CL, and CH. Satisfactory materials for grading shall be comprised of stones less than 200 mm , except for fill material for pavements and railroads which shall be comprised of stones less than 75 mm in any dimension.

1.2.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. The Contracting Officer shall be notified of any contaminated materials.

1.2.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines have a plasticity index of 0.. Testing required for classifying materials shall be in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140.

1.2.4 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557, Method C abbreviated as a percent of laboratory maximum density.

1.2.5 Topsoil

Material suitable for topsoils obtained from offsite areas and excavations.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Earthwork; FIO.

Procedure and location for disposal of unused satisfactory material. Blasting plan when blasting is permitted. Proposed source of borrow material.

SD-09 Reports

Testing; GA.

Within 24 hours of conclusion of physical tests, 3 copies of test results, including calibration curves and results of calibration tests.

SD-13 Certificates

Testing; GA.

Qualifications of the commercial testing laboratory or Contractor's testing facilities.

SD-18 Records

Earthwork; GA.

Notification of encountering rock in the project. Advance notice on the opening of excavation or borrow areas. Advance notice on shoulder construction for rigid pavements.

1.4 SUBSURFACE DATA

Subsurface soil boring logs are shown on the drawings. The subsoil investigation report may be examined at the Fort Worth District Office, Corps of Engineers. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.5 CLASSIFICATION OF EXCAVATION

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

1.5.1 Common Excavation

Common excavation shall include the satisfactory removal and disposal of all materials not classified as rock excavation.

1.6 BLASTING

Blasting will not be permitted.

1.7 UTILIZATION OF EXCAVATED MATERIALS

Unsatisfactory materials removed from excavations shall be disposed of in designated waste disposal or spoil areas. Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be disposed of in designated areas approved for surplus material storage or designated waste areas as directed. Newly designated waste areas on Government-controlled land shall be cleared and grubbed before disposal of waste material thereon. Coarse rock from excavations shall be stockpiled and used for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. No excavated material shall be disposed of to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 STRIPPING OF TOPSOIL

Where indicated or directed, topsoil shall be stripped to a depth of 150 millimeters. Topsoil shall be spread on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Topsoil shall be kept separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 50 mm in diameter, and other materials that would interfere with planting and maintenance operations. Any surplus of topsoil from excavations and grading shall be removed from the site.

3.2 GENERAL EXCAVATION

The Contractor shall perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Grading shall be in conformity with the typical sections shown and the tolerances specified in paragraph FINISHING. Satisfactory excavated materials shall be transported to and placed in fill or embankment within the limits of the work. Unsatisfactory materials encountered within the limits of the work shall be excavated below grade and replaced with satisfactory materials as directed. Payment therefore will be in conformance with the "Changes" clause of the Contract Clauses. Surplus satisfactory excavated material not required for fill or embankment shall be disposed of in areas approved for surplus material storage or designated waste areas. Unsatisfactory excavated material shall be disposed of in designated waste or spoil areas. During construction, excavation and fill shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from the borrow areas indicated or from other approved areas selected by the Contractor as specified.

3.2.1 Ditches, Gutters, and Channel Changes

Excavation of ditches, gutters, and channel changes shall be accomplished by cutting accurately to the cross sections, grades, and elevations shown. Ditches and gutters shall not be excavated below grades shown. Excessive open ditch or gutter excavation shall be backfilled with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown. Material excavated shall be disposed of as shown or as directed, except that in no case shall material be deposited less than 1 meter from the edge of a ditch. The Contractor shall maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.2.2 Drainage Structures

Excavations shall be made to the lines, grades, and elevations shown, or as directed. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Rock or other hard foundation material shall be cleaned of loose debris and cut to a firm, level, stepped, or serrated surface. Loose disintegrated rock and thin strata shall be removed. When concrete or masonry is to be placed in an excavated area, the bottom of the excavation shall not be disturbed. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

3.3 SELECTION OF BORROW MATERIAL

Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from approved sources, either private or within the limits of the project site, selected by the Contractor. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation.

3.4 OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS

Except as otherwise permitted, borrow pits and other excavation areas shall be excavated providing adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed of as directed. Borrow pits shall be neatly trimmed and drained after the excavation is completed. The Contractor shall ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.5 BACKFILL

Backfill adjacent to any and all types of structures shall be placed and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials to prevent wedging action or eccentric loading upon or against the structure. Ground surface on which backfill is to be placed shall be prepared as specified in paragraph PREPARATION OF GROUND SURFACE FOR FILLS OR EMBANKMENTS. Compaction requirements for backfill materials shall also conform to the applicable portions of paragraphs PREPARATION OF GROUND SURFACE FOR FILLS OR EMBANKMENTS, EMBANKMENTS, and SUBGRADE PREPARATION, and Section 02630 STORM-DRAINAGE SYSTEM; and Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.6 PREPARATION OF GROUND SURFACE FOR FILLS OR EMBANKMENTS

3.6.1 General Requirements

Ground surface on which fill is to be placed shall be stripped of live, dead, or decayed vegetation, rubbish, debris, and other unsatisfactory material; plowed, disked, or otherwise broken up to a depth of 150 mm; pulverized; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. The prepared ground surface shall be scarified and moistened or aerated as required just prior to placement of fill or

embankment materials to assure adequate bond between fill or embankment material and the prepared ground surface.

3.6.2 Frozen Material

Embankment shall not be placed on a foundation which contains frozen material, or which has been subjected to freeze-thaw action. This prohibition encompasses all foundation types, including the natural ground, all prepared subgrades (whether in an excavation or on an embankment) and all layers of previously placed and compacted earth fill which become the foundations for successive layers of earth fill. All material that freezes or has been subjected to freeze-thaw action during the construction work, or during periods of temporary shutdowns, such as, but not limited to, nights, holidays, weekends, winter shutdowns, or earthwork operations, shall be removed to a depth that is acceptable to the Contracting Officer and replaced with new material. Alternatively, the material will be thawed, dried, reworked, and recompacted to the specified criteria before additional material is placed. The Contracting Officer will determine when placement of fill shall cease due to cold weather. The Contracting Officer may elect to use average daily air temperatures, and/or physical observation of the soils for his determination. Embankment material shall not contain frozen clumps of soil, snow, or ice.

3.7 FILLS OR EMBANKMENTS

3.7.1 Earth Fills or Embankments

Earth fills or embankments shall be constructed from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 75 mm. The material shall be placed in successive horizontal layers of loose material not more than 150 millimeters in depth. Each layer shall be spread uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, each layer shall be plowed, disked, or otherwise broken up; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. The moisture content shall be at least one (1) percent above optimum during compaction. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements shall be identical with those requirements specified in paragraph RAW SUBGRADE PREPARATION. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.8 RAW SUBGRADE PREPARATION

3.8.1 Construction

Raw subgrade shall be shaped to line, grade, and cross section, and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain specified compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with satisfactory excavated material or other approved material as directed. Rock encountered in the cut section shall be excavated to a depth of 150 mm below finished grade for the raw subgrade. Low areas resulting from removal of unsatisfactory material or excavation of rock shall be brought up to required grade with satisfactory materials, and the entire raw

subgrade shall be shaped to line, grade, and cross section and compacted as specified. After rolling, the surface of the raw subgrade for roadways shall not show deviations greater than 3 millimeter when tested with a 3.6 meter straightedge applied both parallel and at right angles to the centerline of the area. The elevation of the finish raw subgrade shall not vary more than 15 mm from the established grade and cross section.

3.8.2 Compaction

Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas and railroads, each layer of the embankment shall be compacted to at least 90 percent of laboratory maximum density.

3.8.2.1 Raw Subgrade for Railroads

Subgrade for railroads shall be compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials.

3.8.2.2 Raw Subgrade for Pavements

Raw subgrade for pavements shall be compacted to at least 90 percentage laboratory maximum density for the depth below the surface of the pavement shown.

3.8.2.3 Raw Subgrade for Shoulders

Raw subgrade for shoulders shall be compacted to at least 90 percentage laboratory maximum density for the depth below the surface of shoulder shown.

3.9 SHOULDER CONSTRUCTION

Shoulders shall be constructed of satisfactory excavated or borrow material or as otherwise shown or specified. Shoulders shall be constructed as soon as possible after adjacent paving is complete, but in the case of rigid pavements, shoulders shall not be constructed until permission of the Contracting Officer has been obtained. The entire shoulder area shall be compacted to at least the percentage of maximum density as specified in paragraph RAW SUBGRADE PREPARATION above, for specific ranges of depth below the surface of the shoulder. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Shoulder construction shall be done in proper sequence in such a manner that adjacent ditches will be drained effectively and that no damage of any kind is done to the adjacent completed pavement. The completed shoulders shall be true to alignment and grade and shaped to drain in conformity with the cross section shown.

3.10 FINISHING

The surface of excavations, fills, embankments, and subgrades shall be finished to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. The degree of finish for graded areas shall be within 30 mm of the grades and elevations indicated except that the degree of finish for raw subgrades shall be specified in paragraph RAW SUBGRADE PREPARATION. Gutters and ditches shall be finished

in a manner that will result in effective drainage. The surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials.

3.11 TESTING

Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. [AM #1] Technicians performing density testing shall be NICET Level I soils certified. If the Contractor elects to establish testing facilities, no work requiring testing will be permitted until the Contractor's facilities have been inspected and approved by the Contracting Officer. The first inspection will be at the expense of the Government. Cost incurred for any subsequent inspections required because of failure of the first inspection will be charged to the Contractor. Field in-place density shall be determined in accordance with ASTM D 1556 ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using only the sand cone method as described in ASTM D 1556. ASTM D 2922results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017; the calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, the material shall be removed, replaced and recompacted to meet specification requirements. Tests on recompacted areas shall be performed to determine conformance with specification requirements. All inspections and test results shall be certified by a registered professional civil engineer employed full time with a testing laboratory. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.11.1 Fill and Backfill Material Gradation

One test per 1500 cubic meters stockpiled or in-place source material. Gradation of fill and backfill material shall be determined in accordance with ASTM C 136, ASTM D 422, ASTM D 1140.

3.11.2 In-Place Densities

a. One test per 1600 square meters, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

b. One test per 100 square meters, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

c. One test per 10 linear meters, or fraction thereof, of each lift of fill, or backfill [AM #1] for roads.

d. One test per 30 linear meters, or fraction thereof, of each lift of embankment or backfill for railroads.

3.11.3 Check Tests on In-Place Densities

If ASTM D 2922 is used, in-place densities shall be checked by ASTM D 1556 as follows:

a. One check test per lift for each 8300 square meters, or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines.

b. One check test per lift for each 500 square meters, of fill or backfill areas compacted by hand-operated machines.

c. One check test per lift for each 50 linear meters, or fraction thereof, of embankment or backfill for roads .

d. One check test per lift for each 150 linear meters, or fraction thereof, of embankment or backfill for railroads.

3.11.4 Moisture Contents

In the stockpile, excavation, or borrow areas, a minimum of two tests per day per type of material or source of material being placed during stable weather conditions shall be performed. During unstable weather, tests shall be made as dictated by local conditions and approved by the Contracting Officer.

3.11.5 Optimum Moisture and Laboratory Maximum Density

Tests shall be made for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 1500 cubic meters of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.11.6 Tolerance Tests for Raw Subgrades

Continuous checks on the degree of finish specified in paragraph RAW SUBGRADE PREPARATION shall be made during construction of the subgrades.

3.12 RAW SUBGRADE AND FILL OR EMBANKMENT PROTECTION

During construction, fills embankments and excavations shall be kept shaped and drained. Ditches and drains along raw subgrade shall be maintained to drain effectively at all times. The finished raw subgrade shall not be disturbed by traffic or other operation and shall be protected and maintained by the Contractor in a satisfactory condition until subbase, base, or pavement is placed. The storage or stockpiling of materials on the finished raw subgrade will not be permitted. No subbase, base course, ballast, or pavement shall be laid until the raw subgrade has been checked and approved, and in no case shall subbase, base, surfacing, pavement, or ballast be placed on a muddy, spongy, or frozen raw subgrade.

-- End of Section --

SECTION 02316

EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS
11/97
Amendment #0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.2 DEGREE OF COMPACTION

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557, Method C.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Field Density Tests; FIO. Testing of Backfill Materials; FIO.

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Satisfactory Materials

Satisfactory materials shall comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM,SC, and CL.

2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, frozen material, and stones larger than 75 mm . The Contracting Officer shall be notified of any contaminated materials.

2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials shall include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM shall be identified as cohesionless only when the fines are nonplastic.

2.1.4 Rock

Rock shall consist of boulders measuring 1/2 cubic meter or more and materials that cannot be removed without systematic drilling and blasting such as rock material in ledges, bedded deposits, unstratified masses and conglomerate deposits, and below ground concrete or masonry structures, exceeding 1/2 cubic meter in volume, except that pavements shall not be considered as rock.

2.1.5 Unyielding Material

Unyielding material shall consist of rock and gravelly soils with stones greater than 75 millimeters in any dimension or as defined by the pipe manufacturer, whichever is smaller.

2.1.6 Unstable Material

Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.

2.1.7 Select Granular Material

Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material

passing a 0.075 mm mesh sieve and no less than 95 percent by weight passing the 25 mm sieve. The maximum allowable aggregate size shall be 75 millimeters, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

2.1.8 Initial Backfill Material

Initial backfill shall consist of select granular material or satisfactory materials free from rocks 25 millimeters or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, the initial backfill material shall be free of stones larger than 25 millimeters in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

2.2 PLASTIC MARKING TAPE

Plastic marking tape shall be acid and alkali-resistant polyethylene film, 152 mm (6 inches) wide with minimum thickness of 0.102 mm (0.004 inch). Tape shall have a minimum strength of 12.1 MPa (1750 psi) lengthwise and 10.3 MPa (1500 psi) crosswise. The tape shall be of a type specifically manufactured for marking and locating underground utilities. Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription describing the specific utility.

TABLE 1. Tape Color

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone, Telegraph, Television, Police, and Fire Communications
Blue:	Water Systems
Green:	Sewer Systems

PART 3 EXECUTION

3.1 EXCAVATION

Excavation shall be performed to the lines and grades indicated. Excavation will be unclassified regardless of the nature of materials encountered. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to 1/2 the depth of the excavation, but in no instance closer than 600 mm. Excavated material not required or not satisfactory for backfill shall be removed from the site. Grading shall be done as may be necessary to prevent surface water from flowing into the excavation, and any water accumulating shall be removed to maintain the stability of the bottom and sides of the excavation. Unauthorized overexcavation shall be backfilled in accordance with paragraph BACKFILLING AND COMPACTION at no additional cost to the Government.

3.1.1 Trench Excavation Requirements

The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be sloped, or made vertical, and of such width as recommended in the manufacturer's installation manual. Where no manufacturer's installation manual is available, trench walls shall be made vertical. Trench walls

more than 1.5 meters high shall be shored, cut back to a stable slope, or provided with equivalent means of protection for employees who may be exposed to moving ground or cave in. Vertical trench walls more than 1.5 meters high shall be shored. Trench walls which are cut back shall be excavated to at least the angle of repose of the soil. Special attention shall be given to slopes which may be adversely affected by weather or moisture content. The trench width below the top of pipe shall not exceed 600 mm (24 inches) plus pipe outside diameter (O.D.) for pipes of less than 600 mm (24 inches) inside diameter and shall not exceed 900 mm (36 inches) plus pipe outside diameter for sizes larger than 600 mm (24 inches) inside diameter. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the Contractor. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost to the Government.

3.1.1.1 Bottom Preparation

The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 75 millimeters or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

3.1.1.2 Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, such material shall be removed 100 millimeters below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

3.1.1.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.

3.1.1.4 Excavation for Appurtenances

Excavation for manholes, catch-basins, inlets, or similar structures shall be sufficient to leave at least 300 mm clear between the outer structure surfaces and the face of the excavation or support members. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

3.1.1.5 Jacking, Boring, and Tunneling

Unless otherwise indicated on the drawings, excavation shall be by open cut

except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Contracting Officer, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections. Pipe shall be installed using approved jacking, boring, or tunneling procedures. Pipe and conduit smaller than 910 mm in diameter shall be installed in a smooth Standard weight steel pipe casing. A minimum clearance of at least 50 mm between the inner wall of the sleeve and maximum outside diameter of the sleeved pipe and joint shall be provided. Sand bedding shall be provided for the utility pipe or conduit through the sleeve. The Contractor shall submit the plan of 0a proposed installation procedures for approval in accordance with the SPECIAL CLAUSES. The plan shall include pipe guides, jack positions, jacking head, tunnel liner when required, jointing methods, and other specifics pertinent to the procedure selected. The approval of this plan by the Contracting Officer shall not relieve the Contractor from 0a responsibility to obtain the specified results.

a. Jacking

If the grade of the pipe at the jacking end is-below the ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the jacking operations and for placing end joints of the pipe. Wherever end trenches are cut in the sides of the embankment or beyond it, such work shall be sheathed securely and braced in a satisfactory manner to prevent earth caving. Where pipe is required to be installed under railroad embankments or under streets, or other facilities by jacking or boring methods, construction shall be made in such a manner that will not interfere with the operation of the railroad, street, or other facility, and shall not weaken or damage any embankment or structure. During construction operations, barricades and lights to safeguard traffic and pedestrians shall be furnished and maintained, as directed by the Contracting Officer, until such time as the backfill has been completed and then shall be removed from the site. Heavy duty jacks suitable for forcing the pipe through the embankment shall be provided. In operating jacks, even pressure shall be applied to all jacks used. A suitable jacking head, usually of timber, and suitable bracing between jacks and jacking head ahall be provided so that pressure will be applied to the pipe uniformly around the ring of the pipe. A suitable jacking frame or back stop ahall be provided. The pipe to be jacked ahall be set on guides, properly braced together to support the section of the pipe and to direct it in the proper line and grade. The whole jacking assembly shall be placed so as to line up with the direction and grade of the pipe. In general, embankment material ahall be excavated just ahead of the pipe and material removed through the pipe, and the pipe forced through the embankment with jacks, into the space thus provided. The distance that the excavation shall extend beyond the end of the pipe depends on the character of the material, but it ahall not exceed A 610 mm in any case. This distance ahall be decreased on instructions from the Contracting Officer, if the character of the material being excavated makes it desirable to keep the advance excavation closer to the end of the pipe. The pipe, preferably, shall be jacked from the low or downstream end. Lateral or vertical variation in the final position of the pipe from the line and grade established by the Contracting Officer will be permitted only to the extent of 25 mm in 3.05 meters, provided that such variation shall be regular and only in one direction and that the final grade of flow line shall be in the direction indicated on the plans. If the Contractor desires, he may use a cutting edge of steel placed around the head end of the pipe extending a short distance beyond the end of the pipe with inside

angles or lugs to keep the cutting edge from slipping back onto the pipe. When jacking of pipe is once begun, the operation shall be carried on without interruption, insofar as practicable, to prevent the pipe from becoming firmly set in the embankment. Any pipe damaged in jacking operations shall be removed and replaced by the Contractor at his entire expense. The pits or trenches excavated to facilitate jacking operations shall be backfilled immediately after the jacking of the pipe has been completed.

b. Boring

The boring shall proceed from a pit provided for the boring equipment and workmen. Excavation for pits and installation of shoring shall be as outlined above under paragraph Jacking. The location of the pit shall meet the approval of the Contracting Officer. The holes are to be bored mechanically. The boring shall be done using a pilot hole. By this method an approximate 50 mm pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. This pilot hole shall serve as the centerline of the -larger diameter hole to be bored. Excavated material will be placed near the top of the working pit and disposed of as required. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings; jetting will not be permitted. In unconsolidated soil formations, a gel-forming colloidal drilling fluid consisting of at least 10 percent of high grade carefully processed bentonite may be used to consolidate cuttings of the bit, seal the walls of the hole, and furnish lubrication for subsequent removal of cuttings and installation of the pipe immediately thereafter. Allowable variation from line and grade shall be as specified under paragraph Jacking. Overcutting in excess of 25 mm shall be remedied by pressure grouting the entire length of the installation.

c. Tunneling

Where the characteristics of the soil would make the use of tunneling more satisfactory than jacking or boring. Tunneling method may be used. The excavation for pits and the installation of shoring shall be as outlined above under paragraph Jacking. The lining of the tunnel shall be of steel of sufficient strength to support the overburden. The Contractor shall submit his proposed liner method to the Contracting Officer for approval. Approval by the Contracting Officer shall not relieve the Contractor of the responsibility for the adequacy of the liner method. The apace between the liner plate and the limits of excavation shall be preeaure-grouted or mudjacked. Access holes for placing concrete shall be spaced at maximum intervals of 3 meters.

3.1.2 Stockpiles

Stockpiles of satisfactory and unsatisfactory materials shall be placed and graded as specified. Stockpiles shall be kept in a neat and well drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared, grubbed, and sealed by rubber-tired equipment, excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the

stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no additional cost to the Government. Locations of stockpiles of satisfactory materials shall be subject to prior approval of the Contracting Officer.

3.2 BACKFILLING AND COMPACTION

Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding 150 mm loose thickness for compaction by hand operated machine compactors, and 200 mm loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 95 percent maximum density for cohesionless soils and 90 percent maximum density for cohesive soils, unless otherwise specified.

3.2.1 Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall be backfilled to 600 mm above the top of pipe prior to performing the required pressure tests. The joints and couplings shall be left uncovered during the pressure test.

3.2.1.1 Replacement of Unyielding Material

Unyielding material removed from the bottom of the trench shall be replaced with select granular material or initial backfill material.

3.2.1.2 Replacement of Unstable Material

Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 150 mm loose thickness.

3.2.1.3 Bedding and Initial Backfill

Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

3.2.1.4 Final Backfill

The remainder of the trench, except for special materials for roadways, and railroads, shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:

a. Roadways andRailroads: Backfill shall be placed up to the elevation at which the requirements in Section 02300 EARTHWORK control, or up to the bottom of the concrete backfill indicated for pavement replacement. Water flooding or jetting methods of compaction will not be permitted.

b. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 300 mm loose thickness, and compacted to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless

soils. Water jetting shall not be allowed to penetrate the initial backfill.Compaction by water flooding or jetting will not be permitted. This requirement shall also apply to all other areas not specifically designated above.

3.2.2 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 3 days, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be placed in 150 mm lifts and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress. Each lift shall be tested for density.

3.3 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.3.1 Gas Distribution

Trenches shall be excavated to a depth that will provide not less than 450 mm of cover in rock excavation and not less than 900 mm of cover in other excavation. Trenches shall be graded as specified for pipe-laying requirements in Section 02685 GAS DISTRIBUTION SYSTEM.

3.3.2 Water Lines

Trenches shall be of a depth to provide a minimum cover as follows from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe. TM-813-5, WATER DISTRIBUTION SYSTEMS requires a minimum cover over water pipes of 760 mm in grassed areas, 910 mm under driveways or roadways, and 1220 mm under railroad tracks.

3.3.3 Heat Distribution System

Initial backfill material shall be free of stones larger than 6.3 mm in any dimension.

3.3.4 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 600 mm from the finished grade, unless otherwise indicated. Special trenching requirements for direct-burial electrical cables and conduits are specified in Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

3.3.5 Plastic Marking Tape

Warning tapes shall be installed directly above the pipe, at a depth of 300 millimeters below finished grade unless otherwise shown.

3.4 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government.

3.4.1 Testing Facilities

Tests shall be performed by an approved commercial testing laboratory or may be tested by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved by the Contracting Officer. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the first inspection will be charged to the Contractor.

3.4.2 Testing of Backfill Materials

Characteristics of backfill materials shall be determined in accordance with particle size analysis of soils ASTM D 422 and moisture-density relations of soils ASTM D 1557. A minimum of one particle size analysis and one moisture-density relation test shall be performed on each different type of material used for bedding and backfill.

3.4.3 Field Density Tests

Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. A minimum of one field density test per lift of backfill for every [AM #1] 100 meters of installation shall be performed. One moisture density relationship shall be determined for every 1500 cubic meters of material used. Field in-place density shall be determined in accordance with ASTM D 1556 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using the sand cone method as described in paragraph Calibration of the ASTM publication. ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the Contracting Officer. Copies of calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the Contracting Officer. Trenches improperly compacted shall be reopened to the depth directed, then refilled and compacted to the density specified at no additional cost to the Government. [AM #1] All testing technicians shall be NICET Level I Soils certified.

3.4.4 Displacement of Sewers

After other required tests have been performed and the trench backfill compacted to 600 mm above the top of the pipe, the pipe shall be inspected to determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Contracting Officer. Pipe sizes larger than 900 mm (36 inches) shall be entered and examined, while smaller diameter pipe shall be inspected by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgement of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied as directed at no additional cost to the Government.

-- End of Section --

SECTION 02556

ASPHALTIC BITUMINOUS HEAVY-DUTY PAVEMENT (CENTRAL-PLANT HOT MIX)
06/91
Amendment #0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 29	(1991a) Unit Weight and Voids in Aggregate
ASTM C 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 117	(1990) Materials Finer than 75-micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	(1993) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1989) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1993) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 183	(1988) Sampling and the Amount of Testing of Hydraulic Cement
ASTM D 5	(1986) Penetration of Bituminous Materials
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 242	(1985; R 1990) Mineral Filler for Bituminous Paving Mixtures
ASTM D 946	(1982; R 1993) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 1559	(1989); Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus

ASTM D 1250	(1980; R 1990) Petroleum Measurement Tables
ASTM D 1856	(1979; R 1984) Recovery of Asphalt from Solution by Abson Method
ASTM D 2041	(1991) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 2172	(1993) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil, and Rock
ASTM D 3381	(1992) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	(1989) Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
ASTM D 4791	(1989) Flat or Elongated Particles in Coarse Aggregate

DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, HANDBOOK FOR CONCRETE AND CEMENT (CRD)

CRD-C 649	(1995) Standard Test Method for Unit Weight, Marshall Stability, and Flow Mixtures
CRD-C 650	(1995) Standard Test Method for Density and Percent Voids in Compacted Bituminous Paving Mixtures
CRD-D 652	(1995) Standard Test Method for Measurement of Reduction in Marshall Stability of Bituminous Mixtures Caused by Immersion in Water

[AM #1]

TEXAS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS: (TXDOT)

TXDOT-01	(1993) Standard Specifications for Construction of Highways, Streets and Bridges

1.2 GRADE CONTROL

Lines and grades shown on contract drawings for each pavement category of contract shall be established and maintained by means of line and grade stakes placed at site of work by the Contractor in accordance with the SPECIAL CLAUSES. Elevations of bench marks used by the Contractor for controlling pavement operations at the site of work will be determined, established, and maintained by the Government. Finished pavement elevations shown shall be established and controlled at the site of work by the Contractor in accordance with bench mark elevations furnished by the Contracting Officer.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Test Results; FIO.

Contractor Quality Control test results.

1.4 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.4.1 Storage of Bituminous Paving Mixture

Storage of bituminous paving mixture shall conform to the applicable requirements of ASTM D 3515; however, in no case shall the mixture be stored for more than 4 hours.

1.4.2 Transportation of Bituminous Mixture

Transportation from the paving plant to the site shall be in trucks having tight, clean, smooth beds lightly coated with an approved releasing agent to prevent adhesion of mixture to truck bodies. Excessive releasing agent shall be drained prior to loading. Each load shall be covered with canvas or other approved material of ample size to protect mixture from weather and to prevent loss of heat. Loads that have crusts of cold, unworkable material or have become wet by rain will be rejected. Hauling over freshly placed material will not be permitted.

1.4.3 Mineral Aggregates

Mineral aggregates shall be delivered to the site of the bituminous mixing plant and stockpiled in such manner as to preclude fracturing of aggregate particles, segregation, contamination, or intermingling of different materials in the stockpiles or cold-feed hoppers. Mineral filler shall be delivered, stored, and introduced into the mixing plant in a manner to preclude exposure to moisture or other detrimental conditions.

1.4.4 Bituminous Materials

Bituminous materials shall be maintained at appropriate temperature during storage but shall not be heated by application of direct flame to walls of storage tanks or transfer lines. Storage tanks, transfer lines, and weigh bucket shall be thoroughly cleaned before a different type or grade of bitumen is introduced into the system. The asphalt cement shall be heated sufficiently to allow satisfactory pumping of the material; however, the storage temperature shall be maintained below 150 degrees C.

1.5 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.5.1 General

The bituminous plant shall be of such capacity, as specified herein to produce the quantities of bituminous mixtures required for the project.

Hauling equipment, paving machines, rollers, miscellaneous equipment, and tools shall be provided in sufficient numbers and capacity and in proper working condition to place the bituminous paving mixtures at a rate equal to the plant output. Diesel fuel shall not be used to clean roller tires or wheels.

1.5.2 Mixing Plants

1.5.2.1 General

The mixing plant shall be an automatic or semiautomatic controlled, commercially manufactured unit designed and operated to consistently produce a mixture within the tolerances specified for the job-mix formula (JMF). The plant shall have a minimum capacity of 90 metric tons per hour.

1.5.2.2 Drum Mixer

Drum mixers shall be prequalified at the production rate to be used during actual mix production. The prequalification tests will include extraction and recovery of the asphalt cement in accordance with ASTM D 2172 and ASTM D 1856. The penetration of the recovered asphalt binder shall not be less than 60 percent of the original penetration, as measured in accordance with ASTM D 5.

1.5.3 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 3.66 meter (12 foot) straightedge for each bituminous paver. Straightedge shall be made available for Government use. Straightedge shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to ensure rigidity and accuracy. Straightedge shall have handles to facilitate movement on pavement.

1.6 ACCESS TO PLANT AND EQUIPMENT

The Contracting Officer shall have access at all times to all parts of the paving plant for checking adequacy of equipment in use; inspecting operation of plant; verifying weights, proportions, and character of materials; and checking temperatures maintained in preparation of mixtures.

1.7 [AM #1] Not Used

PART 2 PRODUCTS

2.1 AGGREGATES

Aggregates shall consist of natural sand, crushed stone, crushed gravel, crushed slag, screenings, sand, and mineral filler, as required. The portion of materials retained on the 4.75 sieve shall be known as coarse aggregate; the portion passing the 4.75 sieve and retained on the 0.075 sieve as fine aggregate; and the portion passing the 0.075 sieve as mineral filler. Aggregate gradation shall conform to gradation(s) specified in TABLE I. TABLE I is based on aggregates of uniform specific gravity; the percentage passing various sieves may be changed by the

Contracting Officer when aggregates of varying specific gravities are used. Adjustments of percentages passing various sieves may be directed by the Contracting Officer when aggregates vary more than 0.2 in specific gravity.

TABLE I AGGREGATE GRADATION

19.1 mm Maximum

Sieve Size	Wearing course (Percent by Weight Passing)
25.0 mm	-
19.0 mm	100
12.5 mm	82-96
9.5 mm	75-89
4.75 mm	59-73
2.36 mm	46-60
1.18 mm	34-48
0.60 mm	24-38
0.30 mm	15-27
0.15 mm	8-18
0.075 mm	3-6

[AM #1] As an option, the Contractor may use a Type "D" mix design in accordance with TXDOT-01, Item 340, if the mix design meets the requirements of Paragraph 2.5.3, Table III or IV.

2.1.1 Coarse Aggregate

Coarse aggregate shall consist of clean, sound, durable particles meeting the following requirements:

a. Percentage of loss shall not exceed 40 percent after 500 revolutions, as determined in accordance with ASTM C 131.

b. Percentage of loss shall not exceed 18 after five cycles performed in accordance with ASTM C 88, using magnesium sulfate.

c. Slag shall be air-cooled blast furnace slag. Other slag shall not be permitted. The dry weight of crushed slag shall not be less than 1200 kilograms per cubic meter, as determined in accordance with ASTM C 29.

d. Crushed gravel retained on the 4.75 mm sieve and each coarser sieve listed in TABLE I shall contain at least 75 percent by weight of crushed pieces having two or more fractured faces with the area of each face equal to at least 75 percent of the smallest midsectional area of piece. When two fractures are contiguous, the angle between planes of fractures shall be at least 30 degrees to count as two fractured faces.

e. Particle shape of crushed aggregates shall be essentially cubical. Quantity of flat and elongated particles in any sieve size shall not exceed 20 percent by weight, when determined in accordance with ASTM D 4791.

2.1.2 Fine Aggregates

Fine aggregate shall consist of clean, sound, durable, angular particles produced by crushing stone, slag, or gravel that meets requirements for wear and soundness specified for coarse aggregate. Fine aggregates produced by crushing gravel shall have at least 90 percent by weight of crushed particles having two or more fractured faces in the portion retained on the 0.60 mm sieve. This requirement shall apply to material before blending with natural sand, when blending is necessary. Quantity of natural sand to be added to the wearing-and intermediate-course mixtures shall not exceed 15 percent by weight of coarse and fine aggregate and material passing the 0.075 sieve. Natural sand shall be clean and free from clay and organic matter. Percentage of loss shall not exceed 15 after five cycles of the soundness test performed in accordance with ASTM C 88, using magnesium sulfate.

2.1.3 Mineral Filler

Mineral filler shall conform to ASTM D 242.

2.2 BITUMINOUS MATERIALS

Asphalt cement shall conform to ASTM D 3381, Grade AC-20.

2.3 ADDITIVES

The use of additives such as antistripping and antifoaming agents is subject to approval.

2.4 BITUMINOUS HOT MIX

Bituminous hot mix shall consist of coarse aggregate, fine aggregate, mineral filler, bituminous material, and approved additives, if required, of the qualities and in the proportions specified and shall conform to requirements contained in paragraphs PROPORTIONING OF MIXTURE and ACCEPTABILITY OF WORK.

2.5 PROPORTIONING OF MIXTURE

2.5.1 Test Properties of Bituminous Mixtures

Finished mixture shall meet requirements described below when tested in accordance with CRD-C 649-95, CRD-C 650-95, and ASTM D 1559. All samples will be compacted with 75 blows of specified hand-held hammer on each side of sample (or mechanical equipment providing compaction equivalent to a hand-held hammer.) When bituminous mixture fails to meet the requirements specified below, the paving operation shall be stopped until the cause of noncompliance is determined and corrected.

2.5.2 Stability, Flow and Voids

Requirements for stability, flow, and voids are shown in TABLES III and IV for nonabsorptive and absorptive aggregates, respectively.

TABLE III NONABSORPTIVE-AGGREGATE MIXTURE (1)

	Wearing Course
Stability minimum, newtons	8000
Flow maximum, 25/100-mm units	16
Voids total mix, percent (1)	3-5
Voids filled with bitumen, percent	70-80

(1) The Contracting Officer may permit deviations from limits specified for voids filled with bitumen in the intermediate course in order to stay within limits for percent voids total mix.

TABLE IV ABSORPTIVE-AGGREGATE MIXTURE (1)

	Wearing Course
Stability minimum, newtons	8000
Flow maximum, 25/100-mm units units	16
Voids total mix, percent (1)	2-4
Voids filled with bitumen, percent	75-85

(1) The Contracting Officer may permit deviations from limits specified for voids filled with bitumen in the intermediate course in order to stay within the limits for percent voids total mix.

2.5.2.1 Nonabsorptive Aggregate

When the water-absorption value of the entire blend of aggregate does not exceed 2.5 percent, as determined in accordance with ASTM C 127 and ASTM C 128, the aggregate is designated as nonabsorptive. The theoretical specific gravity computed from the apparent specific gravity or ASTM D 2041 will be used in computing voids total mix and voids filled with bitumen, and the mixture shall meet the requirements in TABLE III.

2.5.2.2 Absorptive Aggregate

When the water-absorption value of the entire blend of aggregate exceeds 2.5 percent as determined in accordance with ASTM C 127 and ASTM C 128, the aggregate is designated as absorptive. The theoretical specific gravity computed from the bulk-impregnated specific gravity method contained in ASTM D 2041 shall be used in computing percentages of voids total mix and voids filled with bitumen; the mixture shall meet requirements in TABLE IV.

2.5.2.3 Antistripping Agent

The index of retained stability shall be greater than 75 percent as determined by CRD-C 652-95. When the index of retained stability is 75 percent or less, aggregate stripping tendencies shall be countered by the use of hydrated lime or by treating the bitumen with an approved antistripping agent. The hydrated lime will be considered as mineral filler and will be considered in the gradation requirements. The amount of hydrated lime or antistripping agent added to bitumen will be determined during development of the Job Mix Formula, and will be sufficient, to produce an index of retained stability greater than 75 percent. Use of additional antistripping agent may be directed during progress of the work, if necessary. No additional payment will be made to the Contractor for addition of antistripping agent required.

PART 3 EXECUTION

3.1 WEATHER LIMITATIONS

Bituminous courses shall not be constructed when the temperature of the surface of the existing pavement or base course is below 5 degrees C.

3.2 BASE COURSE CONDITIONING

Surface of the base course will be inspected for adequate compaction and surface tolerances specified in Section 02722 Aggregate Base Course. Unsatisfactory areas shall be corrected.

3.3 SURFACE PREPARATION OF UNDERLYING COURSE

Prior to the placing of wearing course, the underlying course shall be cleaned of all dust and other foreign or objectionable matter with power brooms and hand brooms.

3.4 PREPARATION OF BITUMINOUS MIXTURES

Mixing time shall be as required to obtain a uniform coating of the aggregate with the bituminous material. Temperature of bitumen at the time of mixing shall not exceed 150 degrees C. Temperature of aggregate and mineral filler in the mixer shall not exceed 165 degrees C when bitumen is added. Overheated and carbonized mixtures or mixtures that foam shall not be used.

3.5 WATER CONTENT OF AGGREGATES

Drying operations shall reduce the water content of mixture to less than 0.75 percent. Water content test will be conducted in accordance with ASTM D 2216; weight of sample will be at least 500 grams. If water content is determined on hot bin samples, the water content will be a weighted average based on the composition of the blend.

3.6 PRIME COATING

Surface of previously constructed base course shall be sprayed with a coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COAT.

3.7 TACK COATING

Contact surfaces of previously constructed pavement, curbs, manholes, and other structures to be contacted by the bituminous mat shall be sprayed with a thin coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COAT.

3.8 PLACING

Bituminous courses shall be constructed only when the base course has no free water on the surface. Bituminous mixtures shall not be placed without ample time to complete spreading and rolling during daylight hours, unless approved satisfactory artificial lighting is provided.

3.8.1 Joints in Succeeding Course

Longitudinal joints shall be constructed so that the joint in each succeeding course is offset at least 300 mm (12 inches) from the previous one. Transverse joints in each course shall be constructed so that they are offset by at least 600 mm (2 feet) from a joint in any lower course. All joints in every course shall have neat, dense vertical faces; wedge type joints will not be permitted, except for transverse joints at the end of a leveling course, where approved. Where this is not attained otherwise, sawing will be required. Where drawings do not exactly define thickness or extent of a leveling course, the Contractor shall assure that the depth and extent is controlled so that no overlaying course will be placed at less than the thickness indicated, and in no case less than 38 mm (1-1/2 inches).

3.8.2 General Requirements for Use of Mechanical Spreader

The temperature of the bituminous mixture when dumped into the hopper of the paver (mechanical spreader) shall be between 120 and 130 degrees C. If less than 120 degrees C, the mixture shall be wasted. The mechanical spreader shall be adjusted and the speed regulated so that the surface of the course being laid will be smooth and continuous without tears and pulls, and of such depth that, when compacted, the surface will conform to the cross section indicated. Placing centerline areas with crowned sections or high side of areas with one-way slope shall be as directed. Placing of the mixture shall be as nearly continuous as possible, and the speed of placing shall be adjusted, as directed, to permit proper rolling. When segregation occurs in the mixture during placing, the spreading operation shall be suspended until the cause is determined and corrected.

3.8.3 Placing Strips Succeeding Initial Strips

In placing each succeeding strip after the initial strip has been spread and compacted as specified below, the screed of the mechanical spreader shall overlap the previously placed strip 50 to 75 mm and be sufficiently high so that subsequent compaction produces a smooth dense joint. Mixture placed on the edge of a previously placed strip by the mechanical spreader shall be pushed back to the edge of the strip by the use of a lute. Excess material shall be removed and wasted.

3.8.4 Handspreading in Lieu of Machine Spreading

In isolated areas where use of machine spreading is impractical, the mixture shall be spread by hand. Spreading shall be in a manner to prevent

segregation. The mixture shall be spread uniformly with hot rakes in a loose layer of thickness that, when compacted, will conform to the required grade, density, and thickness.

3.9 JOINTS

3.9.1 General

Joints between old and new pavements, between successive days' work, or joints that have become cold (less than 80 degrees C) because of any delay, shall be sawed back to ensure continuous bond between the old and new sections of the course. All joints shall have the same texture and smoothness as other sections of the course. Contact surfaces of previously constructed pavements coated by dust, sand, or other objectionable material shall be cleaned by brushing or shall be cut back as directed. When directed by the Contracting Officer, the surface against which new material is placed shall be sprayed with a thin, uniform coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS. Material shall be applied far enough in advance of the placement of fresh mixture to ensure adequate curing. Care shall be taken to prevent damage or contamination of the sprayed surface.

3.9.2 Transverse Joint

The roller shall pass over the unprotected end of a strip of freshly placed material only when the placing is discontinued or the delivery of the mixture is interrupted to the extent that material in place may become cold. In all cases, prior to continuing placement, the edge of previously placed pavement shall be cut back by sawing full depth to expose an even vertical surface for full thickness of the course. In continuing placement of the strip, the mechanical spreader shall be positioned on the transverse joint so that sufficient hot mixture will be spread to obtain a joint after rolling that conforms to the required density and smoothness specified herein.

3.9.3 Longitudinal Joints

Edges of a previously placed strip shall be prepared such that the pavement in and immediately adjacent to the joint between this strip and the succeeding strip meets the requirements for grade, smoothness, and density as described in paragraph ACCEPTABILITY OF WORK.

3.10 COMPACTION OF MIXTURE

Rolling shall begin as soon after placing as the mixture will bear a roller without undue displacement. Delays in rolling freshly spread mixture will not be permitted. After initial rolling, preliminary tests of crown, grade, and smoothness shall be made by the Contractor. Deficiencies shall be corrected so that the finished course will conform to requirements for grade and smoothness specified herein. After the crown, grade, and smoothness requirements have been met, rolling shall be continued until a mat density of 98.0 to 100.0 percent and a joint density of at least 96.5 percent of density of laboratory-compacted specimens of the same mixture are obtained. The density will be determined and evaluated as specified in paragraph PERCENT PAYMENT. Places inaccessible to rollers shall be thoroughly compacted with hot hand tampers.

3.10.1 Testing of Mixture

At the start of the plant operation, a quantity of mixture shall be prepared sufficient to construct a test section at least 50 meters long, two spreader widths wide and of thickness to be used in the project. Mixture shall be placed, spread, and rolled with the equipment to be used in the project and in accordance with requirements specified above. This test section will be tested and evaluated as a lot and shall conform to all specification requirements. If approved by the Contracting Officer, the test section may be located in one of the less critical areas of the project pavement construction. Otherwise, it shall be located outside the project paving. If tests results are satisfactory, the test section shall remain in the place as part of the completed pavement if constructed in the project pavement area. If tests indicate that the pavement does not conform to specification requirements, the test section shall be removed and the material disposed of off-site. Necessary adjustments to the plant operations and rolling procedures shall be made immediately, and another test section constructed, all at no additional cost to the Government. Other additional test sections, as necessary and as directed, shall be constructed and will be sampled and tested for conformance with specification requirements. In no case shall the Contractor start full production of an intermediate or wearing course mixture without approval.

3.10.2 Correcting Deficient Areas

Mixtures that become contaminated or are defective shall be removed to the full thickness of the course. Edges of the area to be removed shall be cut so that the sides are perpendicular and parallel to the direction of traffic and so that the edges are vertical. Edges shall be sprayed with bituminous materials conforming to Section 02748 BITUMINOUS TACK AND PRIME COAT. Fresh paving mixture shall be placed in the excavated areas in sufficient quantity so that the finished surface when compacted will conform to the grade and smoothness requirements. Paving mixture shall be compacted to the density specified herein. Skin patching or feather edging of an area that has been rolled shall not be permitted.

3.11 PROTECTION OF PAVEMENT

After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until the pavement has cooled to 60 degrees C.

3.12 TESTS

The extent and frequency of testing and inspection shall be sufficient to assure that all materials, operations, and finished products meet all requirements of these specifications and at least consist of the following minimum amount. All testing shall be performed by an approved commercial testing laboratory, unless the Contractor has an in-house testing laboratory which has been inspected and approved by the Contracting Officer. The methods used for sampling and testing shall be the same as those specified for Government quality assurance testing. Reports shall be prepared of all testing and inspection and shall be submitted within 24 hours of the time sampling or testing took place. Minimum acceptable extent of testing and inspection shall be as follows:

a. Hot Bin Gradations. Hot Bin Gradations (cold feed gradation when drum plant is used) shall be tested in accordance with ASTM C 136. A minimum of one test per 180 metric tons or fraction thereof shall be performed.

b. Marshall Specimens. Marshall Specimens shall be taken in accordance with CRD-C 652. At least one set of specimens (three specimens per set) shall be taken once per 180 metric tons or fraction thereof.

c. Asphalt Extractions. Asphalt Extractions shall be taken in accordance with ASTM D 2172, Method A or E. The Contractor may use asphalt furnances in lieu of extractors to determine gradation asphalt content. These tests shall be performed once per 180 metric tons or fraction thereof.

d. Field Densitiy Tests. Field Density Tests (three specimens per set) shall be conducted in accordance with CRD-C 650. A minimum of one test per 180 metirc tons or fraction thereof. Each set will have two mats and one joint core samples. Joint cores will be drilled directly on centerline of two adjacent lanes.

e. Thickness Measurements. Thickness Measurements will be determined on drilled core samples and reported.

-- End of Section --

SECTION 02721

SUBBASE COURSES
03/97
Amendment #0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(1993) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 29	(1991a) Unit Weight and Voids in Aggregate
ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1995a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1991) Density of Soil and Soil-Aggregate

	in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4318	(1993) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes

1.2 DEGREE OF COMPACTION

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557. In this specification, degree of compaction shall be a percentage of laboratory maximum density.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment; FIO.

List of proposed equipment to be used in performance of construction work, including descriptive data.

SD-09 Reports

Sampling and Testing; GA.
Copies of initial and in-place test results.

1.4 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved testing laboratory in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Tests shall be performed at the specified frequency. No work requiring testing will be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements.

1.4.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.4.2 Tests

1.4.2.1 Sieve Analysis

Sieve analysis shall be made in conformance with ASTM C 117 and ASTM C 136. Sieves shall conform to ASTM E 11. A minimum of one analysis shall be performed for each 2,500 square meters or fraction thereof, of material placed.

1.4.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318. One test each for liquid limit and plasticity index shall be performed for each sieve analysis.

1.4.2.3 Moisture-Density Determinations

The maximum density and optimum moisture shall be determined in accordance with ASTM D 1557 [AM #1] Method C.

1.4.2.4 Density Tests

Density shall be field measured in accordance with ASTM D 1556 [AM #1] _____ or ASTM D 2922. The calibration curves shall be checked and adjusted, if necessary, using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D 2922 result in a wet unit weight of soil and, when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration, in ASTM D 2922, on each different type of material to be tested at the beginning of a job and at intervals as directed. At least one field density test shall be performed for each 900 square meters of each 150 mm thick layer of compacted material or fraction thereof.

1.4.2.5 Wear Test

Wear tests shall be made on subbase course material in conformance with ASTM C 131. One test shall be run for each 2,500 square meters of completed subbase course, or fraction thereof.

1.4.2.6 Weight of Slag

Weight per cubic meter of slag shall be determined in accordance with ASTM C 29 on the subbase course material.

1.4.2.7 Laboratory Maximum Density

At least one test for moisture density relationship shall be run for each type of material or combination of material.

1.4.2.8 Thickness

At least one measurement for each 400 square meters (500 square yards) of

subbase course.

1.4.3 Testing Frequency

1.4.3.1 Initial Tests

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements prior to installation.

a. Sieve Analysis not including 0.02 mm size material
b. Liquid limit and plasticity index moisture-density relationship
c. Wear
d. Weight per cubic meter of Slag

1.4.3.2 In-Place Tests

One of each of the following tests shall be performed on samples taken from the placed and compacted subbase course. Samples shall be taken for each 1000 square meters of each layer of material placed in each area.

a. Sieve Analysis not including 0.02 mm size material
b. Field Density
c. Moisture liquid limit and plasticity index

1.4.4 Approval of Material

The source of the material shall be selected 60 days prior to the time the material will be required in the work. Approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and compacted subbase course.

1.5 WEATHER LIMITATIONS

Construction shall be done when the atmospheric temperature is above 2 degrees C. When the temperature falls below 2 degrees C, the Contractor shall protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

1.6 EQUIPMENT

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Subbase Course

Aggregates shall consist of crushed stone or slag, gravel, shell, sand, or other sound, durable, approved materials processed and blended or naturally

combined. Aggregates shall be durable and sound, free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. Material retained on the 4.75 mm sieve shall have a percentage of wear not to exceed 50 percent after 500 revolutions when tested as specified in ASTM C 131. Aggregate shall be reasonably uniform in density and quality. Slag shall be an air-cooled, blast-furnace product having a dry weight of not less than 1050 kg/cubic meter. Aggregates shall have a maximum size of 50 mm and shall be within the limits specified as follows:

Maximum Allowable Percentage by Weight

Passing Square-Mesh Sieve

Sieve Designation	No. 1
2 mm	50
0.075 mm	15

The portion of any blended component and of the completed course passing the 0.425 mm shall be either nonplastic or shall have a liquid limit not greater than 25 and a plasticity index not greater than 5.

PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES

All clearing, stripping and excavating work involved in the opening or operation of aggregate sources shall be performed by the Contractor. Aggregate sources shall be opened to working depth in a manner that produces excavation faces that are as nearly vertical as practicable for the materials being excavated. Materials excavated from aggregate sources shall be obtained in successive cuts extending through all exposed strata. All pockets or strata of unsuitable materials overlying or occurring in the deposit shall be wasted as directed. The methods of operating aggregate sources and the processing and blending of the material may be changed or modified by the Contracting Officer, when necessary, in order to obtain material conforming to specified requirements. Aggregate sources on private lands shall be conditioned in agreement with local laws and authorities.

3.2 STOCKPILING MATERIAL

Prior to stockpiling of material, storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the Contracting Officer so as to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.3 PREPARATION OF UNDERLYING MATERIAL

Prior to constructing the subbase course, the underlying course or subgrade shall be cleaned of all foreign substances. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. Ruts, or soft yielding spots, in the underlying courses, subgrade areas having inadequate compaction, and deviations of the surface from the specified requirements, shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the subbase course. Stabilization shall be accomplished by mixing subbase-course material into the underlying course, and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements for the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the subbase course is placed.

3.4 GRADE CONTROL

The finished and completed subbase course shall conform to the lines, grades, and cross sections shown. The lines, grades, and cross sections shown shall be maintained by means of line and grade stakes placed by the Contractor at the work site.

3.5 MIXING AND PLACING MATERIALS

The materials shall be mixed and placed to obtain uniformity of the subbase material at the water content specified. The Contractor shall make such adjustments in mixing or placing procedures or in equipment as may be directed to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to insure a satisfactory subbase course.

3.6 LAYER THICKNESS

The compacted thickness of the completed course shall be as indicated. When a compacted layer of 150 mm is specified, the material may be placed in a single layer; when a compacted thickness of more than 150 mm is required, no layer shall exceed 150 mm nor be less than 75 mm when compacted.

3.7 COMPACTION

Each layer of the subbase course shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within plus or minus one percent of optimum water content, as determined from laboratory tests, as specified in paragraph SAMPLING AND TESTING. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction shall continue until each layer is compacted through the full depth to at least the percent of laboratory maximum density shown on the drawings. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory subbase course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or

reworked, as directed, to meet the requirements of this specification.

3.8 EDGES

Approved material shall be placed along the edges of the subbase course in such quantity as will compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, at least a 300 mm width of the shoulder shall be rolled and compacted simultaneously with the rolling and compacting of each layer of the subbase course, as directed.

3.9 SMOOTHNESS TEST

The surface of each layer shall not show deviations in excess of 10 mm when tested with a 3.6 m (12 foot) straightedge applied parallel with and at right angles to the centerline of the area to be paved. Deviations exceeding this amount shall be corrected by removing material, replacing with new material, or reworking existing material and compacting, as directed.

3.10 THICKNESS CONTROL

The completed thickness of the subbase course shall be in accordance with the thickness and grade indicated on the drawings. The thickness of each course shall be measured at intervals providing at least one measurement for each 400 square meters or part thereof of subbase course. The thickness measurement shall be made by test holes, at least 75 mm in diameter through the course. The completed subbase course shall not be more than 13 mm deficient in thickness nor more than 13 mm above or below the established grade. Where any of these tolerances are exceeded, the Contractor shall correct such areas by scarifying, adding new material of proper gradation or removing material, and compacting, as directed. Where the measured thickness is 13 mm or more thicker than shown, the course will be considered as conforming with the specified thickness requirements plus 13 mm. The average job thickness shall be the average of the job measurements as specified above but within 6 mm of the thickness shown.

3.11 MAINTENANCE

The subbase course shall be maintained in a satisfactory condition until accepted.

-- End of Section --

SECTION 02722

AGGREGATE BASE COURSE
09/98
Amendment #0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 29/C 29M	(1997) Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Course Aggregate
ASTM C 128	(1993) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D 2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1996) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4318	(1995a) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire Cloth Sieves for Testing Purposes

TEXAS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS: (TXDOT)

TXDOT-01	(1993) Standard Specifications for Construction of Highways, Streets and Bridges

1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.2.1 Aggregate Base Course

Aggregate base course (ABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.2.2 Degree of Compaction

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Plant, Equipment, and Tools; FIO.

List of proposed equipment to be used in performance of construction work, including descriptive data.

SD-09 Reports

Sampling and testing; FIO. Field Density Tests; FIO.

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within 24 hours

after the tests are performed. Certified copies of test results for approval not less than 30 days before material is required for the work.

1.4 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by a testing laboratory approved in accordance with Section 01451 CONTRACTOR QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements; testing shall be performed at the specified frequency. The Contracting Officer may specify the time and location of the tests. Copies of test results shall be furnished to the Contracting Officer within 24 hours of completion of the tests.

1.4.1 Sampling

Samples for laboratory testing shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.4.2 Tests

The following tests shall be performed in conformance with the applicable standards listed.

1.4.2.1 Sieve Analysis

Sieve analysis shall be made in conformance with ASTM C 117 and ASTM C 136, and ASTM D 422. Sieves shall conform to ASTM E 11. After the initial test, a minimum of one analysis shall be performed for each 907 kg of material [AM #1] delivered with a minimum of three analyses for each day's run until the course is completed.

1.4.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318. One liquid limit and plasticity index shall be performed for each sieve analysis.

1.4.2.3 Moisture-Density Determinations

The maximum density and optimum moisture content shall be determined in accordance with ASTM D 1557,[AM #1] Method C.

1.4.2.4 Field Density Tests

Density shall be field measured in accordance with ASTM D 1556 orASTM D 2922. For the method presented in ASTM D 1556 the base plate as shown in the drawing shall be used. For the method presented in ASTM D 2922 the calibration curves shall be checked and adjusted if necessary using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D 2922 result in a wet unit weight of soil and when using this method, ASTM D 3017 shall be

used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration of ASTM D 2922, on each different type of material being tested at the beginning of a job and at intervals as directed. At least one field density test shall be performed for each 836 square meters of each layer of base course constructed.

1.4.2.5 Wear Test

Wear tests shall be made on ABC course material in conformance with ASTM C 131. One test shall be run per 2508 square meters of completed course. A minimum of one test per aggregate source shall be run.

1.4.2.6 Weight of Slag

Weight per cubic meter of slag shall be determined in accordance with ASTM C 29/C 29M on the ABC course material.

1.4.3 Testing Frequency

1.4.3.1 Initial Tests

One of each of the following tests shall be performed on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

a. Sieve Analysis.

b. Liquid limit and plasticity index moisture-density relationship.

c. Moisture-density relationship.

d. Wear.

e. Weight per cubic meter of Slag.

1.4.3.2 In Place Tests

One of each of the following tests shall be performed on samples taken from the placed and compacted ABC. Samples shall be taken and tested at the rates indicated.

a. Density tests shall be performed on every lift of material placed and at a frequency of one set of tests for every 836 square meters, or portion thereof, of completed area.

b. Sieve Analysis shall be performed for every 500 metric tons, or portion thereof, of material placed.

c. Liquid limit and plasticity index tests shall be performed at the same frequency as the sieve analysis.

d. Wear tests shall be performed in accordance with ASTM C 131. One test shall be run per 2508 square meters of completed base course. A minimum of one test per aggregate source shall be run.

1.4.4 Approval of Material

The source of the material shall be selected 60 days prior to the time the material will be required in the work. Tentative approval of material will be based on initial test results. Final approval of the materials will be based on sieve analysis, liquid limit, and plasticity index tests performed on samples taken from the completed and fully compacted ABC.

1.5 WEATHER LIMITATIONS

Construction shall be done when the atmospheric temperature is above 2 degrees C. When the temperature falls below 2 degrees C, the Contractor shall protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

1.6 PLANT, EQUIPMENT, AND TOOLS

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

PART 2 PRODUCTS

2.1 AGGREGATES

The ABC shall consist of clean, sound, durable particles of crushed stone, crushed slag, crushed gravel, crushed recycled concrete, angular sand, or other approved material. ABC shall be free of lumps of clay, organic matter, and other objectionable materials or coatings. The portion retained on the 4.75 mm sieve shall be known as coarse aggregate; that portion passing the 4.75 mm sieve shall be known as fine aggregate.

2.1.1 Coarse Aggregate

Coarse aggregates shall be angular particles of uniform density. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements and shall be stockpiled separately.

a. Crushed Gravel: Crushed gravel shall be manufactured by crushing gravels, and shall meet all the requirements specified below.

b. Crushed Stone: Crushed stone shall consist of freshly mined quarry rock, and shall meet all the requirements specified below.

c. Crushed Recycled Concrete: Crushed recycled concrete shall consist of previously hardened portland cement concrete or other concrete containing pozzolanic binder material. The recycled material shall be free of all reinforcing steel, bituminous concrete surfacing, and any other

foreign material and shall be crushed and processed to meet the required gradations for coarse aggregate. Crushed recycled concrete shall meet all other applicable requirements specified below.

d. Crushed Slag: Crushed slag shall be an air-cooled blast-furnace product having an air dry unit weight of not less than 1045 kg/cubic meter as determined by ASTM C 29/C 29M, and shall meet all the requirements specified below.

2.1.1.1 Aggregate Base Course

ABC coarse aggregate shall not show more than 50 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C 131. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, the crushed aggregates shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the piece. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to count as two fractured faces. Crushed gravel shall be manufactured from gravel particles 50 percent of which, by weight, are retained on the maximum size sieve listed in TABLE 1.

2.1.2 Fine Aggregate

Fine aggregates shall be angular particles of uniform density. When the fine aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements.

2.1.2.1 Aggregate Base Course

ABC fine aggregate shall consist of screenings, angular sand, crushed recycled concrete fines, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.

2.1.3 Gradation Requirements

Requirements for gradation specified shall apply to the completed base course. The aggregates shall be continuously graded within the following limits:

	Percentage by Weight Passing
Sieve Designation	Square-Mesh Sieve*
44 mm	100
22 mm	65-90
9.5 mm	50-70
No. 4	35-55
No. 40	15-30

*The table is based on aggregates of uniform specific gravity and the percentages passing the various sieves are subject to appropriate corrections in accordance with ASTM C 127 and C 128 when aggregates of "varying specific gravity are used." The gradation above conforms to Texas Department of Transportation Standard Specification for base course, Item 247, Type A, Grade1.

2.1.4 Liquid Limit and Plasticity Index

Liquid limit and plasticity index requirements shall apply to the completed course and shall also apply to any component that is blended to meet the required gradation. The portion of any component or of the completed course passing the 0.425 mm sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the ABC is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF AGGREGATE SOURCES

Aggregates shall be obtained from offsite sources.

3.3 STOCKPILING MATERIAL

Prior to stockpiling of material, storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the Contracting Officer to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.4 PREPARATION OF UNDERLYING COURSE

Prior to constructing the ABC, the underlying course or subgrade shall be cleaned of all foreign substances. At the time of construction of the ABC, the underlying course shall contain no frozen material. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. The underlying course shall conform to Section 02721 SUBBASE COURSES. Ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses containing sands or gravels, as defined in ASTM D 2487, the surface shall be stabilized prior to placement of the ABC. Stabilization shall be accomplished by mixing ABC into the underlying course and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements of the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the ABC is placed.

3.5 INSTALLATION

3.5.1 Mixing the Materials

The coarse and fine aggregates shall be mixed in a stationary plant, or in a traveling plant or bucket loader on an approved paved working area. The Contractor shall make adjustments in mixing procedures or in equipment as directed to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to insure a satisfactory ABC meeting all requirements of this specification.

3.5.2 Placing

The mixed material shall be placed on the prepared subgrade or subbase in layers of uniform thickness with an approved spreader. When a compacted layer 150 mm or less in thickness is required, the material shall be placed in a single layer. When a compacted layer in excess of 150 mm is required, the material shall be placed in layers of equal thickness. No layer shall exceed 150 mm or less than 75mm when compacted. The layers shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. Where the ABC is placed in more than one layer, the previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms, as directed. Such adjustments in placing procedures or equipment shall be made as may be directed to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to insure an acceptable ABC.

3.5.3 Grade Control

The finished and completed ABC shall conform to the lines, grades, and cross sections shown. Underlying material(s) shall be excavated and prepared at sufficient depth for the required ABC thickness so that the finished ABC with the subsequent surface course will meet the designated grades.

3.5.4 Edges of Base Course

The ABC shall be placed so that the completed section will be a minimum of 1.5 m wider, on all sides, than the next layer that will be placed above it. Additionally, approved fill material shall be placed along the outer edges of ABC in sufficient quantities to compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 600 mm width of this material to be rolled and compacted simultaneously with rolling and compacting of each layer of ABC. If this base course material is to be placed adjacent to another pavement section, then the layers for both of these sections shall be placed and compacted along this edge at the same time.

3.5.5 Compaction

Each layer of the ABC shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the compaction procedure to within plus or minus one percent of the optimum water content determined from laboratory tests as specified in paragraph SAMPLING AND TESTING. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least

one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Compaction shall continue until each layer has a degree of compaction that is at least 100 percent of laboratory maximum density through the full depth of the layer. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory ABC. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

3.5.6 Thickness

Compacted thickness of the aggregate course shall be as indicated. No individual layer shall exceed 200 mm nor be less than 75 mm in compacted thickness. The total compacted thickness of the ABC course shall be within 13 mm of the thickness indicated. Where the measured thickness is more than 13 mm deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 13 mm thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 6 mm of the thickness indicated. The total thickness of the ABC course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square meters of base course. Measurements shall be made in 75 mm diameter test holes penetrating the base course.

3.5.7 Finishing

The surface of the top layer of ABC shall be finished after final compaction by cutting any overbuild to grade and rolling with a steel-wheeled roller. Thin layers of material shall not be added to the top layer of base course to meet grade. If the elevation of the top layer of ABC is 13 mm or more below grade, then the top layer should be scarified to a depth of at least 75 mm and new material shall be blended in and compacted to bring to grade. Adjustments to rolling and finishing procedures shall be made as directed to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, the unsatisfactory portion shall be scarified, reworked and recompacted or it shall be replaced as directed.

3.5.8 Smoothness

The surface of the top layer shall show no deviations in excess of 10 mm when tested with a 3.05 meter straightedge. Measurements shall be taken in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 15 meter intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.6 TRAFFIC

Completed portions of the ABC course may be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

3.7 MAINTENANCE

The ABC shall be maintained in a satisfactory condition until the full pavement section is completed and accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any ABC that is not paved over prior to the onset of winter, shall be retested to verify that it still complies with the requirements of this specification. Any area of ABC that is damaged shall be reworked or replaced as necessary to comply with this specification.

3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Any unsuitable materials that must be removed shall be disposed of as directed. No additional payments will be made for materials that must be replaced.

-- End of Section --

SECTION 02731

AGGREGATE SURFACE COURSE
01/98
Amendment #0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3740	(1996) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

ASTM D 4318	(1995a) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes

1.2 DEGREE OF COMPACTION

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated herein as present laboratory maximum density.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment; FIO.

List of proposed equipment to be used in performance of construction work including descriptive data.

SD-09 Reports

Sampling and Testing; FIO. Density Test; FIO.

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Test results from samples, not less than 30 days before material is required for the work. Results of laboratory tests for quality control purposes, for approval, prior to using the material.

1.4 EQUIPMENT

All plant, equipment, and tools used in the performance of the work covered by this section will be subject to approval by the Contracting Officer before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, and meeting the grade controls, thickness controls, and smoothness requirements set forth herein.

1.5 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory or by the Contractor, subject to approval. If the Contractor elects to establish its own testing facilities, approval of such facilities will be based on compliance with ASTM D 3740. No work requiring testing will be permitted until the Contractor's facilities have been inspected and approved.

1.5.1 Sampling

Sampling for material gradation, liquid limit, and plastic limit tests

shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.5.2 Testing

1.5.2.1 Gradation

Aggregate gradation shall be made in conformance with ASTM C 117, ASTM C 136, and ASTM D 422. Sieves shall conform to ASTM E 11. [AM #1] After the initial test, a minimum of one analysis shall be performed for each 1000 metric tons of material placed.

1.5.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318. [AM #1] One test shall be performed for each sieve analysis.

1.5.3 Approval of Materials

The source of the material to be used for producing aggregates shall be selected 60 days prior to the time the material will be required in the work. Approval of sources not already approved by the Corps of Engineers will be based on an inspection by the Contracting Officer. Tentative approval of materials will be based on appropriate test results on the aggregate source. Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and compacted surface course.

1.6 WEATHER LIMITATIONS

Aggregate surface courses shall not be constructed when the ambient temperatures is below 2 degrees C and on subgrades that are frozen or contain frost. It shall be the responsibility of the Contractor to protect, by approved method or methods, all areas of surfacing that have not been accepted by the Contracting Officer. Surfaces damaged by freeze, rainfall, or other weather conditions shall be brought to a satisfactory condition by the Contractor.

PART 2 PRODUCTS

2.1 AGGREGATES

Aggregates shall consist of clean, sound, durable particles of natural gravel, crushed gravel, crushed stone, sand, slag, soil, or other approved materials processed and blended or naturally combined. Aggregates shall be free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign materials. The Contractor shall be responsible for obtaining materials that meet the specification and can be used to meet the grade and smoothness requirements specified herein after all compaction operations have been completed.

2.1.1 Coarse Aggregates

The material retained on the 5 mm sieve shall be known as coarse aggregate. Coarse aggregates shall be reasonably uniform in density and quality. The coarse aggregate shall have a percentage of wear not to exceed 50 percent after 500 revolutions as determined by ASTM C 131. The amount of flat and/or elongated particles shall not exceed 20 percent. A

flat particle is one having a ratio of width to thickness greater than three; an elongated particle is one having a ratio of length to width greater than three. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the requirements set forth herein.

2.1.2 Fine Aggregates

The material passing the 5 mm sieve shall be known as fine aggregate. Fine aggregate shall consist of screenings, sand, soil, or other finely divided mineral matter that is processed or naturally combined with the coarse aggregate.

2.1.3 Gradation Requirements

Gradation requirements specified in TABLE I shall apply to the completed aggregate surface. It shall be the responsibility of the Contractor to obtain materials that will meet the gradation requirements after mixing, placing, compacting, and other operations. TABLE I shows permissible gradings for granular material used in aggregate surface roads and airfields. Sieves shall conform to ASTM E 11.

TABLE I. GRADATION FOR AGGREGATE SURFACE COURSES

Sieve Designation	Percentage by Weight Passing Square-Mesh Sieve*
25 mm (1-inch)	100
13 mm (1/2-inch)	40 - 70
4.75 mm (No. 4)	20 - 50
2 mm (No. 10)	15 - 40
0.425 mm (No. 40)	10 - 30
0.075 mm (No. 200)	5 - 20

The portion of any blended component and of the completed course passing the 0.425 mm (No. 40(420-micron)) sieve shall have a liquid limit not greater than 32 and a plasticity index not less than 6 and not greater than 12.

*The table is based on aggregates of uniform specific gravity and the percentages passing the various sieves are subject to appropriate corrections in accordance with ASTM C 127 and ASTM C 128 when aggregates of varying specific gravity are used.

2.1.3.1 Contractor's Option

At the discretion of the Contractor, and with notification to the Contracting Officer, the following gradation may be substituted for that shown in paragraph MATERIALS. The gradation selected will be used for the entire area to receive Gravel Surface Course:

a. For Texas, except Red River Army Depot, TX, Longhorn AAP, TX, and Lone Star AAP, TX:

Sieve Designation	Percentage by Weight Passing Square-Mesh Sieve*
44 mm (1-3/4")	100
22 mm (7/8")	65 - 90
9 mm (3/8")	50 - 70
4.75 mm (No. 4)	35 - 55
0.425 mm (No. 40)	15 - 30

The portion of any blended component and of the completed course passing the 0.425 mm (No. 40)(420-micron) sieve shall have a liquid limit not greater than 35 and a plasticity index not less than 6 and not greater than 12.

*The table is based on aggregates of uniform specific gravity and the percentages passing the various sieves are subject to appropriate corrections in accordance with ASTM C 127 and ASTM C 128 when aggregates of varying specific gravity are used. The gradation above conforms to Texas State Department of Highways and Public Transportation Standard Specification for base course, Item 248, Type A, Grade 1.

2.2 LIQUID LIMIT AND PLASTICITY INDEX REQUIREMENTS

The portion of the completed aggregate surface course passing the 0.425 mm sieve shall have a maximum liquid limit of 35 and a plasticity index of 4 to 9.

PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES

Clearing, stripping, and excavating shall be the responsibility of the Contractor. The aggregate sources shall be operated to produce the quantity and quality of materials meeting these specification requirements in the specified time limit. Upon completion of the work, the aggregate sources on Government property shall be conditioned to drain readily and be left in a satisfactory condition. Aggregate sources on private lands shall be conditioned in agreement with local laws or authorities.

3.2 STOCKPILING MATERIALS

Prior to stockpiling the material, the storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled in such a manner that will prevent segregation. Aggregates and binders obtained from different sources shall be stockpiled separately.

3.3 PREPARATION OF UNDERLYING COURSE SUBGRADE

The underlying course, including shoulders, shall be cleaned of all foreign substances. At the time of surface course construction, the underlying course shall contain no frozen material. Ruts or soft yielding spots in the underlying course areas having inadequate compaction and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade and recompacting to density requirements specified in Section 02722 AGGREGATE BASE COURSE. The completed underlying course shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the surface course is placed.

3.4 GRADE CONTROL

During construction, the lines and grades including crown and cross slope indicated for the aggregate surface course shall be maintained by means of line and grade stakes placed by the Contractor in accordance with the SPECIAL CONTRACT REQUIREMENTS.

3.5 MIXING AND PLACING MATERIALS

The materials shall be mixed and placed to obtain uniformity of the material and a uniform optimum water content for compaction. The Contractor shall make adjustments in mixing, placing procedures, or in equipment to obtain the true grades, to minimize segregation and degradation, to obtain the desired water content, and to ensure a satisfactory surface course.

3.6 LAYER THICKNESS

The aggregate material shall be placed on the underlying course in layers of uniform thickness. When a compacted layer of 150 mm or less is specified, the material may be placed in a single layer; when a compacted thickness of more than 150 mm is required, no layer shall exceed 150 mm nor be less than 75 mm when compacted. [AM #1] Thickness measurements shall be taken for each 500 square meters of material placed.

3.7 COMPACTION

Each layer of the aggregate surface course shall be compacted with approval compaction equipment. The water content during the compaction procedure shall be maintained at optimum or at the percentage specified by the Contracting Officer. In locations not accessible to the rollers, the mixture shall be compacted with mechanical tampers. Compaction shall continue until each layer through the full depth is compacted to at least 100 percent of laboratory maximum density. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked to produce a satisfactory material. [AM #1] At least one field density test shall be performed for each 500 square meters of each layer of material placed.

3.8 EDGES OF AGGREGATE-SURFACED ROAD

Approved material shall be placed along the edges of the aggregate surface course in such quantity as to compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, at least 300 mm of shoulder width shall be rolled and compacted simultaneously with the rolling and compacting of each layer of the surface course.

3.9 SMOOTHNESS TEST

The surface of each layer shall not show any deviations in excess of 10 mm (3/8 inch) when tested with a 3 m (10 foot) straightedge applied both parallel with and at right angles to the centerline of the area to be paved. Deviations exceeding this amount shall be corrected by the Contractor by removing material, replacing with new material, or reworking existing material and compacting, as directed. [AM #1] Measurements shall be taken at 15-meter intervals.

3.10 THICKNESS CONTROL

The completed thickness of the aggregate surface course shall be within 13 mm (1/2 inch), plus or minus, of the thickness indicated on plans. The thickness of the aggregate surface course shall be measured at intervals in such manner that there will be a thickness measurement for at least each 500 square meters of the aggregate surface course. The thickness measurement shall be made by test holes at least 75 mm (3 inches) in diameter through the aggregate surface course. When the measured thickness of the aggregate surface course is more than 13 mm (1/2 inch) deficient in thickness, the Contractor, at no additional expense to the Government, shall correct such areas by scarifying, adding mixture of proper gradation, reblading, and recompacting, as directed. Where the measured thickness of the aggregate surface course is more than 13 mm (1/2 inch) thicker than that indicated, it shall be considered as conforming with the specified thickness requirements plus 13 mm (1/2 inch). The average job thickness shall be the average of the job measurements determined as specified above,

but shall be within 6 mm (1/4 inch) of the thickness indicated. When the average job thickness fails to meet this criterion, the Contractor shall, at no additional expense to the Government, make corrections by scarifying, adding or removing mixture of proper gradation, and reblading and recompacting, as directed.

3.11 DENSITY TESTS

Density shall be measured in the field in accordance with ASTM D 1556 or ASTM D 2922. [AM #1]
For the method presented in ASTM D 2922 the calibration curves shall be checked and adjusted, if necessary, using only the sand cone method as described in paragraph Calibration of the ASTM publication. Tests performed in accordance with ASTM D 2922 result in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration of ASTM D 2922, on each different type of material being tested at the beginning of a job and at intervals, as directed.

3.12 WEAR TEST

Wear tests shall be made in conformance with ASTM C 131. [AM #1] One test shall be performed per 500 square meters of completed surface coarse. A minimum of one test per aggregate source shall be performed.

3.13 MAINTENANCE

The aggregate surface course shall be maintained in a condition that will meet all specification requirements until accepted.

-- End of Section --

SECTION 02741

BITUMINOUS PAVING FOR ROADS, STREETS AND OPEN STORAGE AREAS
09/98
Amendment #0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 117	(1995) Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	(1993) Specific Gravity and Absorption of Fine Aggregate
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 183	(1995a) Sampling and the Amount of Testing of Hydraulic Cement
ASTM D 5	(1995) Penetration of Bituminous Materials
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 2041	(1995) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

ASTM D 2172	(1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 3515	(1996) Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, HANDBOOK FOR CONCRETE AND CEMENT (CRD)

CRD-C 649	(1995) Standard Test Method for Unit Weight, Marshall Stability, and Flow Mixtures
CRD-C 650	(1995) Standard Test Method for Density and Percent Voids in Compacted Bituminous Paving Mixtures
CRD-D 652	(1995) Standard Test Method for Measurement of Reduction in Marshall Stability of Bituminous Mixtures Caused by Immersion in Water

TEXAS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS: (TXDOT)

TXDOT-01	(1993)Standard Specifications for Construction of Highways, Streets and Bridges

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Bituminous Pavement; FIO.

Copies of test results.

SD-14 Samples

Bituminous Pavement; FIO.

Samples of the materials in the quantities indicated below for the job mix formula.

Aggregate and mineral filler (if needed) to be blended in approximately the same proportions as used in the project	100 kg
Asphalt Cement	20 liters

Aggregate samples when new sources are developed, with a plan for operation, 45 days before starting production. Samples of the asphalt cement specified, not less than 60 days before production.

Delivery Tickets; FIO.

Delivery tickets, during progress of the work.

1.3 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.3.1 General

The bituminous plant shall be of such capacity to produce the quantities of bituminous mixtures required. Hauling equipment, paving machines, rollers, miscellaneous equipment, and tools shall be provided in sufficient numbers and capacity and in proper working condition to place the bituminous paving mixtures at a rate equal to the plant output.

1.3.2 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 3.66 m (12-foot) straightedge for each bituminous paver. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to ensure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

1.4 WEATHER LIMITATIONS

Unless otherwise directed, bituminous courses shall not be constructed when temperature of the surface of the existing pavement or base course is below 5 degrees C.

1.5 PROTECTION OF PAVEMENT

After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until the pavement has cooled to 60 degrees C.

1.6 GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS

Finished surface of bituminous courses, when tested as specified below shall conform to gradeline and elevations shown and to surface-smoothness requirements specified.

1.6.1 Plan Grade

The grade of the completed surface shall not deviate more than 15.2 mm (0.05 foot) from the plan grade.

1.6.2 Surface Smoothness

When a 3.66 m (12-foot) straightedge is laid on the surface parallel with the centerline of the paved area or transverse from crown to pavement edge, the surface shall vary not more than 6.4 mm (1/4 inch) from the straightedge.

1.7 GRADE CONTROL

Lines and grades shall be established and maintained by means of line and grade stakes placed at site of work in accordance with the Special Contract Requirements. Elevations of bench marks used by the Contractor for controlling pavement operations at the site of work will be determined, established, and maintained by the Government. Finished pavement elevations shall be established and controlled at the site of work by the Contractor in accordance with bench mark elevations furnished by the Contracting Officer.

1.8 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Unless otherwise specified, sampling shall be in accordance with ASTM D 75 for aggregates, ASTM C 183 for mineral filler, and ASTM D 140 for bituminous material. Copies of test results shall be furnished to the Contracting Officer. Approval of a source does not relieve the Contractor of responsibility for delivery at the job site of materials meeting the requirements herein.

1.8.1 Tests Required

1.8.1.1 Plant Mix

a. Hot Bin Gradations

Hot bin gradations (cold-feed gradation when drum mix plant is used), shall be tested in accordance with ASTM C 136 and ASTM C 117. A minimum of one test will be conducted per every 181,400 kg (200 tons) of wearing course mix placed or fraction thereof.

b. Marshall Specimens

Marshall Specimens shall be taken in accordance with CRD-C 652-95. At least one set of specimens shall be taken per each 181,400 kg (200 tons) of wearing course mix placed. However, not less than two sets of specimens (three specimens per set) shall be taken in any one day regardless of the quantity of mix placed.

c. Asphalt Extractions

Asphalt extractions shall be performed in accordance with ASTM D 2172, Method A or B. At least one asphalt extraction shall be conducted once per 200 metric tons or fraction thereof.

1.8.1.2 Field Density Tests

Field Density Tests shall be conducted in accordance with CRD-C 650-95. A minimum of one test, three specimens per test [AM #1](two cores on mat and one core on joint), shall be conducted per every 181,400 kg (200 tons) of wearing course mix placed or fraction thereof.

1.8.1.3 Thickness Measurements

Thickness Measurements shall be taken at a minimum of one measurement for each 836 square meters (1000 square yards) of mix placed.

1.9 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.9.1 Mineral Aggregates

Mineral aggregates shall be delivered to the site of the bituminous mixing plant and stockpiled in such manner as to preclude fracturing of aggregate particles, segregation, contamination, or intermingling of different materials in the stockpiles or cold-feed hoppers. Mineral filler shall be delivered, stored, and introduced into the mixing plant in a manner to preclude exposure to moisture or other detrimental conditions.

1.9.2 Bituminous Materials

Bituminous materials shall be maintained at appropriate temperature during storage but shall not be heated by application of direct flame to walls of storage tanks or transfer lines. Storage tanks, transfer lines, and weigh buckets shall be thoroughly cleaned before a different type or grade of bitumen is introduced into the system. The asphalt cement shall be heated sufficiently to allow satisfactory pumping of the material; however, the storage temperature shall be maintained below 150 degrees C.

1.10 ACCESS TO PLANT AND EQUIPMENT

The Contracting Officer shall have access at all times to all parts of the paving plant for checking adequacy of the equipment in use; inspecting operation of the plant; verifying weights, proportions, and character of materials; and checking temperatures maintained in preparation of the mixtures.

1.11 DELIVERY TICKETS

Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified delivery tickets for all aggregates and bituminous materials actually used in construction.

PART 2 PRODUCTS

2.1 HOT- MIX Surface Course

Bituminous hot-mix surface course shall conform to the requirements of TXDOT-01 for "Hot-Mix Asphaltic Concrete Pavement," Item 340, except as specified hereinafter.

2.1.1 Asphalt Material

Asphalt material for the surface course shall be asphalt cement AC-20 conforming to TXDOT-01 for "Asphalts, Oils, and Emulsions," Item 300. Asphalt material shall come from a source approved for use by the TXDOT.

The seal number from the tank and the number of the TXDOT Laboratory test report shall be furnished to the Contracting Officer.

2.1.2 Paving Mixture

Paving mixture shall be Type "D".

2.1.3 State Specification Modifications

TXDOT Specification shall be modified as follows:

(a) Material retained on the No. 10 screen shall not exceed 65 percent.

(b) Density and stability requirements shall not apply.

(c) Construction methods paragraph shall not apply.

(d) The measurement and payment paragraphs shall not apply.

2.2 PROPORTIONING OF MIXTURE

2.2.1 Job Mix Formula

The JMF for the bituminous mixture shall be furnished to the Contracting Officer for approval. No payment will be made for mixtures produced prior to the approval of the JMF. The formula will indicate the percentage of each stockpile and mineral filler, the percentage of each size aggregate, the percentage of bitumen, and the temperature of the completed mixture when discharged from the mixer. The tolerances specified in TXDOT-01, "Item 340, will be allowed for asphalt content, temperature, and aggregate grading for tests conducted on the mix as discharged from the mixing plant. Bituminous mix that deviates more than - 4 degrees C (25 degrees F). from the JMF shall be rejected. The JMF may be adjusted during construction to improve paving mixtures, as directed, without adjustments in the contract prices.

2.2.2 Test Properties of Bituminous Mixtures

Finished mixture shall meet requirements described below when tested in accordance with CRD-C 649-95. All samples will be compacted with 50 blows of specified hammer on each side of sample. When bituminous mixture fails to meet the requirements specified below, the paving operation shall be stopped until the cause of noncompliance is determined and corrected.

2.2.2.1 Stability, Flow, and Voids

Requirements for stability, flow, and voids are shown in TABLES III and IV for nonabsorptive and absorptive aggregates, respectively.

Requirements for stability, flow, and voids are shown in TABLES I and II for nonabsorptive and absorptive aggregates, respectively.

TABLES I and II - Not Used.

TABLE III. NONABSORPTIVE-AGGREGATE MIXTURE

	Wearing Course
Stability minimum, pounds	500
Flow maximum, 1/100-inch units	20
Voids total mix, percent (1)	3-5
Voids filled with bitumen, percent (2)	75-85

(1) The Contracting Officer may permit deviations from limits specified when gyratory method of design is used to develop the JMF.

TABLE IV. ABSORPTIVE-AGGREGATE MIXTURE

	Wearing Course
Stability minimum, pounds	500
Flow maximum, 1/100-inch units	20
Voids total mix, percent (1)	2-4
Voids filled with bitumen, percent (2)	80-90

(1) The Contracting Officer may permit deviations from limits specified when gyratory method of design is used to develop the JMF.

a. When the water-absorption value of the entire blend of aggregate does not exceed 2.5 percent as determined in accordance with ASTM C 127 and ASTM C 128, the aggregate is designated as nonabsorptive. The theoretical specific gravity computed from the apparent specific gravity or ASTM D 2041 will be used in computing voids total mix and voids filled with bitumen, and the mixture shall meet requirements in TABLE I.

b. When the water-absorption value of the entire blend of aggregate exceeds 2.5 percent as determined in accordance with ASTM C 127 and ASTM C 128, the aggregate is designated as absorptive. The theoretical specific gravity computed from ASTM D 2041 shall be used in computing percentages of voids total mix and voids filled with bitumen; the mixture shall meet requirements in TABLE II.

2.2.2.2 Stability

The index of retained stability must be greater than 75 percent as determined by CRD-C 652-95. When the index of retained stability is less than 75, the aggregate stripping tendencies may be countered by the use of hydrated lime or by treating the bitumen with an approved antistripping agent. The hydrated lime is considered as mineral filler and should be considered in the gradation requirements. The amount of hydrated lime or antistripping agent added to bitumen shall be sufficient, as approved, to produce an index of retained stability of not less than 75 percent. No additional payment will be made to the Contractor for addition of antistripping agent required.

PART 3 EXECUTION

3.1 BASE COURSE CONDITIONING

The surface of the base course will be inspected for adequate compaction and surface tolerances specified in Section 02722AGGREGATE BASE COURSE. Unsatisfactory areas shall be corrected.

3.2 EXISTING PAVEMENT CONDITIONING

3.3 PREPARATION OF BITUMINOUS MIXTURES

Rates of feed of aggregates shall be regulated so that the moisture content and temperature of aggregates will be within specified tolerances. Aggregates, mineral filler, and bitumen shall be conveyed into the mixer in proportionate quantities required to meet the JMF. Mixing time shall be as required to obtain a uniform coating of the aggregate with the bituminous material. Temperature of bitumen at time of mixing shall not exceed 150 degrees C. Temperature of aggregate and mineral filler in the mixer shall not exceed 160 degrees C when bitumen is added. Overheated and carbonized mixtures or mixtures that foam shall not be used.

3.4 WATER CONTENT OF AGGREGATES

Drying operations shall reduce the water content of mixture to less than 0.75 percent. The water content test will be conducted in accordance with ASTM D 2216; the weight of the sample shall be at least 500 grams. If the water content is determined on hot bin samples, the water content will be a weighted average based on composition of blend.

3.5 STORAGE OF BITUMINOUS PAVING MIXTURE

Storage shall conform to the applicable requirements of ASTM D 3515; however, in no case shall the mixture be stored for more than 4 hours.

3.6 TRANSPORTATION OF BITUMINOUS MIXTURE

Transportation from paving plant to site shall be in trucks having tight, clean, smooth beds lightly coated with an approved releasing agent to prevent adhesion of the mixture to the truck bodies. Excessive releasing agent shall be drained prior to loading. Each load shall be covered with canvas or other approved material of ample size to protect mixture from weather and to prevent loss of heat. Loads that have crusts of cold, unworkable material or that have become wet will be rejected. Hauling over freshly placed material will not be permitted.

3.7 SURFACE PREPARATION OF UNDERLYING COURSE

Prior to placing of the wearing course, the underlying course shall be cleaned of all foreign or objectionable matter with power brooms and hand brooms.

3.8 PRIME COATING

Surfaces of previously constructed base course shall be sprayed with a coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS.

3.9 TACK COATING

Contact surfaces of previously constructed pavement, curbs, manholes, and

other structures shall be sprayed with a thin coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS.

3.10 PLACING

Bituminous courses shall be constructed only when the base course has no free water on the surface. Bituminous mixtures shall not be placed without ample time to complete spreading and rolling during daylight hours, unless approved satisfactory artificial lighting is provided.

3.10.1 General Requirements for Use of Mechanical Spreader

Range of temperatures of mixtures, when dumped into the mechanical spreader, shall be as determined by the Contracting Officer. Mixtures having temperatures less than 110 degrees C when dumped into the mechanical spreader shall not be used. The mechanical spreader shall be adjusted and the speed regulated so that the surface of the course being laid will be smooth and continuous without tears and pulls, and of such depth that, when compacted, the surface will conform to the cross section indicated. Placing with respect to center line areas with crowned sections or high side of areas with one-way slope shall be as directed. Placing of the mixture shall be as nearly continuous as possible, and speed of placing shall be adjusted, as directed, to permit proper rolling. When segregation occurs in the mixture during placing, the spreading operation shall be suspended until the cause is determined and corrected.

3.10.2 Placing Strips Succeeding Initial Strips

In placing each succeeding strip after initial strip has been spread and compacted as specified below, the screed of the mechanical spreader shall overlap the previously placed strip 50 to 75 mm and be sufficiently high so that compaction produces a smooth dense joint. Mixture placed on the edge of a previously placed strip by the mechanical spreader shall be pushed back to the edge of the strip by use of a lute. Excess mixture shall be removed and wasted.

3.10.3 Handspreading in Lieu of Machine Spreading

In areas where the use of machine spreading is impractical, the mixture shall be spread by hand. Spreading shall be in a manner to prevent segregation. The mixture shall be spread uniformly with hot rakes in a loose layer of thickness that, when compacted, will conform to required grade, density, and thickness.

3.11 COMPACTION OF MIXTURE

Rolling shall begin as soon after placing as the mixture will bear a roller without undue displacement. Delays in rolling freshly spread mixture will not be permitted. After initial rolling, preliminary tests of crown, grade, and smoothness shall be made by the Contractor. Deficiencies shall be corrected so that the finished course will conform to requirements for grade and smoothness specified herein. After the Contractor is assured of meeting crown, grade, and smoothness requirements, rolling shall be continued until a mat density of 97.0 to 100.0 percent and a joint density of 95.0 to 100.0 percent of density of laboratory-compacted specimens of the same mixture is obtained. Places inaccessible to rollers shall be thoroughly compacted with hot hand tampers.

3.11.1 Correcting Deficient Areas

Mixtures that become contaminated or are defective shall be removed to the full thickness of the course. Edges of the area to be removed shall be cut so that sides are perpendicular and parallel to the direction of traffic and so that the edges are vertical. Edges shall be sprayed with bituminous materials conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS. Fresh paving mixture shall be placed in the excavated areas in sufficient quantity so that the finished surface will conform to grade and smoothness requirements. Paving mixture shall be compacted to the density specified herein. Skin patching of an area that has been rolled shall not be permitted.

3.12 JOINTS

3.12.1 General

Joints between old and new pavements, between successive work days, or joints that have become cold (less than 80 degrees C) shall be sawed back to ensure continuous bond between the old and new sections of the course. All joints shall have the same texture and smoothness as other sections of the course. Contact surfaces of previously constructed pavements coated by dust, sand, or other objectionable material shall be cleaned by brushing or shall be cut back as directed. When directed by the Contracting Officer, the surface against which new material is placed shall be sprayed with a thin, uniform coat of bituminous material conforming to Section 02748 BITUMINOUS TACK AND PRIME COATS. Material shall be applied far enough in advance of placement of a fresh mixture to ensure adequate curing. Care shall be taken to prevent damage or contamination of the sprayed surface.

3.12.2 Transverse Joints

The roller shall pass over the unprotected end of a strip of freshly placed material only when placing is discontinued or delivery of the mixture is interrupted to the extent that the material in place may become cold. In all cases, prior to continuing placement, the edge of previously placed pavement shall be cut back to expose an even vertical surface for full thickness of the course. In continuing placement of a strip, the mechanical spreader shall be positioned on the transverse joint so that sufficient hot mixture will be spread to obtain a joint after rolling that conforms to the required density and smoothness specified herein.

3.12.3 Longitudinal Joints

Edges of a previously placed strip shall be prepared such that the pavement in and immediately adjacent to the joint between this strip and the succeeding strip meets the requirements for grade, smoothness, and density.

-- End of Section --

SECTION 02753

CONCRETE PAVEMENT FOR HEAVY-DUTY PAVEMENTS
03/97
Amendment #0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214.3R	(1988) Simplified Version of the Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 305R	(1991) Hot Weather Concreting

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(1991) Burlap Cloth Made from Jute or Kenaf

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1997) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 184/A 184M	(1996) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	(1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 497	(1997) Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A 615/A 615M	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A 616M	(1996a) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617/A 617M	(1996a) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM C 29/C 29M	(1997)Bulk Density ("Unit Weight)" and Voids in Aggregate

ASTM C 31/C 31M	(1996) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1997) Concrete Aggregates
ASTM C 39	(1996) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 78	(1994) Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C 94	(1997) Ready-Mixed Concrete
ASTM C 117	(1995) Materials Finer Than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 123	(1996) Lightweight Pieces in Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 142	(1978; R 1990) Clay Lumps and Friable Particles in Aggregates
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 150	(1997) Portland Cement
ASTM C 171	(1997) Sheet Materials for Curing Concrete
ASTM C 172	(1997) Sampling Freshly Mixed Concrete
ASTM C 174/C 174M	(1997) Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C 192/C 192M	(1995) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1995) Air-Entraining Admixtures for Concrete
ASTM C 295	(1990) Petrographic Examination of Aggregates for Concrete
ASTM C 330	(1989) Lightweight Aggregates for Structural Concrete
ASTM C 470	(1994) Molds for Forming Concrete Test

	Cylinders Vertically
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 595	(1995a) Blended Hydraulic Cements
ASTM C 618	(1997) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 881	(1990) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 989	(1997) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1064	(1986; R 1993) Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1077	(1997) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1240	(1997) Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar and Grout
ASTM D 449	(1989; R 1994) Asphalt Used for Dampproofing and Waterproofing
ASTM D 946	(1982; R 1993) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 1227	(1995) Emulsified Asphalt Used as a Protective Coating for Roofing
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1983; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 3665	(1994) Random Sampling of Construction Materials

CALIFORNIA DEPARTMENT OF TRANSPORTATION (CDT)

CDT Test 526	(1978) Operation of California Profilograph and Evaluation of Profiles

ARMY CORPS OF ENGINEERS (COE)

COE CRD-C 55	(1992) Test Method for Within-Batch Uniformity of Freshly Mixed Concrete

COE CRD-C 100	(1975) Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing
COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 114	(1994) Test Method for Soundness of Aggregates by Freezing and Thawing of Concrete Specimens
COE CRD-C 119	(1991) Standard Test Method for Flat or Elongated Particles in Coarse Aggregate
COE CRD-C 130	(1989) Scratch Hardness of Coarse Aggregates Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 171	(1995) Test Method for Determining Percentage of Crushed Particles in Aggregate
COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
COE CRD-C 540	(1971; R 1981) Standard Specification for Nonbituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop

FEDERAL SPECIFICATIONS (FS)

FS TT-P-645	(Rev B) Primer, Paint, Zinc-Molybdenum, Alkyd Type

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(1997) NIST Handbook 44: Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(1996) Concrete Plant Standards

1.2 MEASUREMENT AND PAYMENT

1.2.1 [AM #1] Not Used

1.2.1.1 Mixture Proportions By Contractor

The Contractor shall be responsible for the mixture proportions of cementitious materials and chemical admixtures; no separate measurement or payment will be made for any cementitious material, including pozzolan, or for any chemical admixture.

1.2.1.2 Steel Reinforcement

Fabricated steel bar mats or welded steel wire fabric for reinforcement will not be measured for payment but will be considered as a subsidiary obligation of the Contractor, covered under the price per cubic meter for concrete.

1.2.1.3 Dowels and Tie Bars

The quantity of dowels and tie bars used in the work will not be measured for payment but will be considered as a subsidiary obligation of the Contractor, covered under the price per cubic meter for concrete.

1.2.1.4 Joint Materials

The quantity of expansion joint filler will not be measured for payment but will be considered as a subsidiary obligation of the Contractor, covered under the price per cubic meter for concrete. Joint sealing materials are covered in Section 02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS .

1.2.2 Payments

1.2.2.1 Concrete

The quantity of concrete measured as specified above will be paid for at the contract unit price when placed in completed and accepted pavements. Payment shall be made at the contract price for cubic meter for the scheduled item, with necessary adjustments as specified in paragraph ACCEPTABILITY OF WORK AND PAYMENT ADJUSTMENTS. Payment will constitute full compensation for furnishing all materials, equipment, plant and tools, and for all labor and other incidentals necessary to complete the concrete pavement.

1.3 ACCEPTABILITY OF WORK AND PAYMENT ADJUSTMENTS

Concrete samples shall be taken by the Contractor in the field to determine the slump, air content, and strength of the concrete. Test beams shall be made for determining conformance with the strength requirements of these specifications and, when required, for determining the time at which pavements may be placed into service. Any pavement not meeting the requirement for 'specified strength' shall be removed and replaced at no additional cost to the Government. The air content shall be determined in accordance with ASTM C 231. Slump tests shall be made in accordance with

ASTM C 143. Test beams shall be molded and cured in accordance with ASTM C 31/C 31M and as specified below. Steel molds shall be used for molding the beams specimens. . The Contractor shall furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Laboratory curing facilities for test specimens shall include furnishing and operating water tanks equipped with temperature-control devices that will automatically maintain the temperature of the water at 23 plus or minus 3 degrees C. The Contractor shall furnish and maintain at the site boxes or other facilities suitable for storing the specimens while in the mold at a temperature of 23 plus or minus 6 degrees C. Tests of the fresh concrete and of the hardened concrete specimens shall be made by and at the expense of the Contractor.

1.3.1 Pavement Lots

Appropriate adjustment in payment for individual lots of concrete pavement will be made in accordance with the following paragraphs. No such adjustment in payment will be made for any material other than concrete. A lot will be that quantity of construction that will be evaluated for compliance with specification requirements. A lot will be equal to 8 hour's production. In order to evaluate thickness, each lot will be divided into four equal sublots. Grade and surface smoothness (and condition) determinations will be made on the lot as a whole. However, any pavement not meeting the required 'specified strength' shall be removed and replaced at no additional cost to the Government. Strength will be evaluated, but will not be considered for payment adjustment. Edge slump requirements will be applied to each individual slab into which the primary paving lanes are divided by transverse joints, and will not be considered for payment adjustment. Samples for determining aggregate grading for fine aggregate and each size of coarse aggregate will be taken as the aggregate bins discharge into the weigh hoppers. Results of tests on aggregates shall be used to control aggregate production and concreting operations, as specified in Par. Testing and Inspection for Quality Control, but will not be used for payment adjustment. Samples for determining air content and slump and for fabricating strength specimens shall be taken in accordance with ASTM C 172 during or immediately following delivery of the concrete at the paving site and deposition of the concrete immediately in front of the paver or transfer spreader. Results of strength tests shall be used to control concreting operations, but will not be used for payment adjustment. Cores for thickness determination shall be drilled and evaluated as specified. Location of all samples shall be as directed and will be deliberately selected on a truly random basis, not haphazard, using commonly recognized methods of assuring randomness, employing randomizing tables or computer programs, in accordance with ASTM D 3665.

1.3.2 Acceptance of Lots

When a lot of material fails to meet the specification requirements, that lot will be accepted at a reduced price or shall be removed and replaced. The lowest computed percent payment determined for any pavement characteristic (i.e., thickness, grade, and surface smoothness) discussed below shall be the actual percent payment for that lot. The actual percent payment will be applied to the bid price and the quantity of concrete placed in the lot to determine actual payment.

1.3.3 Evaluation

The Contractor shall provide facilities for and, where directed, personnel to assist in obtaining samples for any Government testing, all at no additional cost to the Government. Such testing will in no way relieve the Contractor of any specified testing responsibilities. The Contractor shall provide all sampling and testing required for acceptance and payment adjustment at its expense. Such sampling and testing shall be performed by a commercial testing laboratory inspected by the Government and approved in writing. The laboratory performing the tests shall be either on-site or off-site and shall conform with ASTM C 1077. The individuals who sample and test concrete or the constituents of concrete as required in this specification shall be certified as American Concrete Institute (ACI) Concrete Field Testing Technicians, Grade I, or shall have otherwise demonstrated to the satisfaction of the Contracting Officer other training providing knowledge and ability equivalent to the ACI minimum requirements for certification. The individuals who perform the inspection of concrete shall be certified as ACI Concrete Construction Inspector, Level II, or have otherwise demonstrated to the satisfaction of the Contracting Officer other training providing knowledge and ability equivalent to the ACI minimum requirements for certification. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C 1077.

1.3.4 Additional Sampling and Testing

The Contracting Officer reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. Testing in these areas will be in addition to the sublot or lot testing, and the requirements for these areas will be the same as those for a sublot or lot, but shall be at no additional cost to the Government.

1.3.5 Air Content Tests

Air content of the concrete shall be controlled as specified in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL and will not be considered for payment adjustment.

1.3.6 Slump Tests

Slump of the concrete shall be controlled as specified in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL and will not be considered for payment adjustment.

1.3.7 Surface Smoothness

The Contractor shall use both of the following methods to test and evaluate surface smoothness of the pavement. All testing shall be performed in the presence of the Contracting Officer's representative. Detailed notes shall be kept of the results of the testing and a copy furnished to the Government immediately after each day's testing. The profilograph method shall be used for all longitudinal and transverse testing, except where the runs would be less than 60 m in length and at the ends where the straightedge shall be used. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), the surface shall be finished to meet the approval of the Contracting Officer.

1.3.7.1 Smoothness Requirements

a. Straightedge Testing: The finished surfaces of the pavements shall have no abrupt change of 3 mm or more, and all pavements shall be within the tolerances specified in Table 1 when checked with an approved 4 m straightedge.

TABLE 1
STRAIGHTEDGE SURFACE SMOOTHNESS--PAVEMENTS

Pavement Category	Direction of Testing	Tolerances mm
All Paved Areas	Longitudinal	10
	Transverse	10

b. Profilograph Testing: The finished surfaces of the pavements shall have no abrupt change of 3 mm or more, and all pavement shall have a Profile Index not greater than specified in Table 2 when tested with an approved California-type profilograph. If the extent of the pavement in either direction is less than 60 m , that direction shall be tested by the straightedge method and shall meet requirements specified for such.

TABLE 2
PROFILOGRAPH SURFACE SMOOTHNESS--PAVEMENTS

Pavement Category	Direction of Testing	Maximum Specified Profile Index mm per km
All Paved Areas	Longitudinal	140
	Transverse	140

1.3.7.2 Testing Method

After the concrete has hardened sufficiently to permit walking thereon, but not later than 36 hours after placement, the surface of the pavement in each entire lot shall be tested by the Contractor in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. However, transverse profilograph testing of multiple paving lanes shall be performed at the timing directed. Separate testing of individual sublots is not required. If any pavement areas are ground, these areas shall be retested immediately after grinding. The entire area of the pavement shall be tested in both a longitudinal and a transverse direction on parallel lines. The transverse lines shall be 4.5 m or less apart, as directed. The longitudinal lines shall be at the centerline of each paving lane shown on the drawings, regardless of whether the Contractor is allowed to pave two lanes at a time, and at the 1/8th point in from each side of the lane. Other areas having obvious deviations shall also be tested. Longitudinal testing lines shall be continuous across all joints. Transverse testing

lines for pilot lanes shall be carried to construction joint lines and for fill-in lanes shall be carried 600 mm across construction joints, and the readings in this area applied to the fill-in lane. Straightedge testing of the longitudinal edges of slipformed pilot lanes shall also be performed before paving fill-in lanes as specified in paragraph "Edge Slump and Joint Face Deformation".

a. Straightedge Testing: The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length and measuring the maximum gap between the straightedge and the pavement surface, in the area between these two high points.

b. Profilograph Testing: Profilograph testing shall be performed using approved equipment and procedures described in CDT Test 526. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for the pavement. The "blanking band" shall be 5 mm wide and the "bump template" shall span 25 mm with an offset of 10 mm. The profilograph shall be operated by an approved, factory-trained operator on the alignments specified above. A copy of the reduced tapes shall be furnished the Government at the end of each day's testing.

1.3.7.3 Payment Adjustment for Smoothness

a. Straightedge Testing: Location and deviation from straightedge for all measurements shall be recorded. When between 5.0 and 10.0 percent and less than 15.0 percent of all measurements made within a lot exceed the tolerance specified in paragraph "Smoothness Requirements" above, after any reduction of high spots or removal and replacement, the computed percent payment based on surface smoothness will be 95 percent. When more than 10.0 percent and less than 15.0 percent of all measurements exceed the tolerance, the computed percent payment will be 90 percent. When between 15.0 and 20.0 percent of all measurements exceed the tolerance, the computed percent payment will be 75 percent. When 20.0 percent or more of the measurements exceed the tolerance, the lot shall be removed and replaced at no additional cost to the Government. Regardless of the above, any small individual area with surface deviation which exceeds the tolerance given above by more than 50 percent shall be corrected by grinding to meet the specification requirements above or shall be removed and replaced at no additional cost to the Government.

b. Profilograph Testing: Location and data from all profilograph measurements shall be recorded. When the Profile Index of a lot exceeds the tolerance specified in paragraph "Smoothness Requirements" above by 16 mm per km but less than 32 mm per km, after any reduction of high spots or removal and replacement, the computed percent payment based on surface smoothness will be 95 percent. When the Profile Index exceeds the tolerance by 32 mm per km but less than 47 mm per km, the computed percent payment will be 90 percent. When the Profile Index exceeds the tolerance by 47 mm per km but less than 63 mm per km, the computed percent

payment will be 75 percent. When the Profile Index exceeds the tolerance by 63 mm per km or more, the lot shall be removed and replaced at no additional cost to the Government. Regardless of the above, any small individual area with surface deviation which exceeds the tolerance given above by more than 79 mm per km or more, shall be corrected by grinding to meet the specification requirements above or shall be removed and replaced at no additional cost to the Government.

c. Bumps ("Must Grind" Areas): Any bumps ("must grind" areas) shown on the profilograph trace which exceed 10 mm in height shall be reduced by grinding in accordance with subparagraph "Areas Defective In Plan Grade Or Smoothness" until they do not exceed 7.5 mm when retested. Such grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. Areas of textured pavement shall be retextured in accordance with the subparagraph listed above. At the Contractor's option, pavement areas including ground areas may be rechecked with the profilograph in order to record a lower Profile Index.

1.3.8 Edge Slump and Joint Face Deformation

The following requirements on testing and evaluation of edge slump and joint face deformation apply only to pavements 250 mm or more in thickness. Use of slip-form paving equipment and procedures that fail to consistently provide edges within the specified tolerances on edge slump and joint face deformation shall be discontinued and the pavements shall be constructed by means of standard paving procedures using fixed forms. Slabs having more than the allowable edge slump shall be removed and replaced as specified in subparagraph "Excessive Edge Slump" before the adjacent lane is placed. Edge slump and joint face deformation will not be applied to payment adjustment.

1.3.8.1 Edge Slump

When slip-form paving is used, not more than 15.0 percent of the total free edge of any slab of the pavement, as originally constructed, shall have an edge slump exceeding 6 mm, and no slab shall have an edge slump exceeding 9 mm as determined in accordance with the measurements as specified in paragraph "Determination of Edge Slump". (The total free edge of the pavement will be considered to be the cumulative total linear measurement of pavement edge originally constructed as non-adjacent to any existing pavement; i.e., 30 m of pilot lane, a paving lane originally constructed as a separate lane, will have 60 m of free edge; 30 m of fill-in lane will have no free edge, etc.,). The area affected by the downward movement of the concrete along the pavement edge shall not exceed 450 mm back from the edge.

1.3.8.2 Joint Face Deformation

In addition to the edge slump limits specified above, the vertical joint face shall have a surface within the maximum limits shown below:

Offset from Straightedge Applied Longitudinally To Pavement Surface 25 mm Back From Joint Line	Offset from Straightedge Applied Longitudinally To Vertical Face	Offset From Straightedge Applied Top To Bottom Against The Joint Face	Abrupt Offset in Any Direction	Offset of Joint Face from True Vertical
All Pavemnt:				
3 mm	6 mm	9 mm	3 mm	8 mm per 100 mm

1.3.8.3 Determination of Edge Slump

Immediately after the concrete has hardened sufficiently to permit walking thereon, the pavement surface shall be tested by the Contractor in the presence of a representative of the Contracting Officer. Testing shall be performed with a straightedge to reveal irregularities exceeding the edge slump tolerance specified above. The edge slump shall be determined at each free edge of each slipformed paving lane constructed. The straightedge shall be placed transverse to the direction of paving and the end of the straightedge located at the edge of the paving lane. Measurements shall be made at 1.5 to 4.5 m spacings, as directed, commencing at the header where paving was started. Initially measurements shall be made at 1.5 m intervals in each lane. When no deficiencies are present, the Contracting Officer may approve an increase in the interval. When any deficiencies exist, the interval will be returned to 1.5 m. In no case shall the interval exceed 4.5 m. In addition to the transverse edge slump determination above, the Contractor, at the same time, shall check the longitudinal surface smoothness of the joint on a continuous line 25 mm back from the joint line using the straightedge advanced one-half its length for each reading. Other tests of the exposed joint face shall be made as directed to ensure that a uniform, true vertical joint face is attained. These tests shall include longitudinal straightedge testing of the vertical face and vertical testing of the face for both smoothness and angle. The measurements shall be made by the Contractor, shall be properly referenced in accordance with paving lane identification and stationing, and a report given to the Contracting Officer within 24 hours after measurement is made. The report shall also identify areas requiring replacement in accordance with paragraph "Excessive Edge Slump" as well as the cumulative percentage of total free edge of pavement constructed to date which has an edge slump exceeding 6 mm.

1.3.8.4 Excessive Edge Slump

When edge slump exceeding the limits specified above is encountered on either side of the paving lane, additional straightedge measurements shall be made, if required, to define the linear limits of the excessive slump. The concrete for the entire width of the paving lane within these limits of excessive edge slump or joint deformation shall be removed and replaced in conformance with paragraph REPAIR, REMOVAL, REPLACEMENT OR SLABS. Partial

slabs removed and replaced shall extend across the full width of the pavement lane, parallel to the transverse joints, and both the section of the slab removed and the section remaining in place shall have a minimum length of 3 m to the nearest scheduled transverse joint. If less than 3 m remains, the entire slab shall be removed and replaced. Adding concrete or paste to the edge or otherwise manipulating the plastic concrete after the sliding form has passed, or patching the hardened concrete, shall not be used as a method for correcting excessive edge slump.

1.3.9 Plan Grade

1.3.9.1 General

The finished surfaces of pavements shall conform, within the tolerances shown below, to the lines, grades, and cross sections shown. The finished surfaces shall vary not more than 18 mm above or below the plan grade line or elevation indicated. Plan grade shall be checked on the lot as a whole and when more than 5.0 and less than 10.0 percent of all measurements made within a lot are outside the specified tolerance, the computed percent payment for that lot will be 95 percent. When more than 10.0 percent are outside the specified tolerances, the computed percent payment for the lot will be 75 percent. However, in any areas where the deviation from grade exceeds the specified tolerances by 50 percent or more, the deficient area shall be removed and replaced at no additional cost to the Government. However, the above deviations from the approved grade line and elevation will not be permitted in areas where closer conformance with the planned grade and elevation is required for the proper functioning of appurtenant structures. The finished surfaces of new abutting pavements shall coincide at their juncture.

1.3.9.2 Grade Conformance Tests

Each pavement category shall be checked by the Contractor for conformance with plan grade requirements. For the purpose of making grade conformance tests, the pavements will be subdivided into the same lots used for all other payment adjustment items. Within 5 days after paving of each lot, the finished surface of the pavement area in each lot shall be tested by the Contractor, in the presence of a representative of the Contracting Officer, by running lines of levels at intervals corresponding with every longitudinal and transverse joint to determine the elevation at each joint intersection. The results of this survey shall be recorded and a copy given to the Government at the completion of the survey of each lot.

1.3.10 Flexural Strength

Each lot of pavement will be evaluated for acceptance in accordance with the following procedures. The Contractor shall be responsible for all testing required herein. Testing shall be performed by an approved commercial laboratory. Results of strength tests will not be used for payment adjustment.

1.3.10.1 Sampling and Testing

One composite sample of concrete from each sublot shall be obtained in accordance with ASTM C 172 from one batch or truckload. [AM #1]

1.3.11 Thickness

Each lot of pavement will be evaluated for acceptance and payment adjustment in accordance with the following procedure. The Contractor shall be responsible for drilling the cores, measuring the cores in the presence of the Contracting Officer's representative, and for filling the core holes as directed.

1.3.11.1 Drilling, Measuring, and Computations

Two cores, between 75 and 150 mm in diameter, shall be drilled from the pavement, per sublot (8 per lot). The Contractor shall fill the core holes with concrete containing an expanding admixture, as directed. The cores shall be evaluated for thickness of the pavement in accordance with ASTM C 174/C 174M. The pavement thickness from the 8 cores for the lot shall be averaged.

1.3.11.2 Evaluation and Payment Adjustment for Thickness

The computed percent payment for thickness shall be determined by entering the following table:

Pavements Over 200 mm in Thickness

Deficiency in Thickness Determined by Cores mm	Computed Percent Payment for Thickness
0 to 6	100
6.5 to 12.5	75
13 to 18.5	50
19 or greater	0

Pavements 200 mm or Less In Thickness

Deficiency in Thickness Determined by Cores mm	Computed Percent Payment for Thickness
0 to 6	100
6.5 to 12.5	65
13 or greater	0

Where 0 percent payment is indicated, the entire lot shall be removed and replaced at no additional cost to the Government. Where either of the two cores from a sublot show a thickness deficiency of 19 mm or greater, two - more cores shall be drilled in the sublot and the average thickness of the four cores computed. If this average shows a thickness deficiency of 19 mm or more, 13 mm for pavements 200 mm or less in thickness, the entire sublot shall be removed.

1.3.12 Partial Lots

When operational conditions cause a lot to be terminated before the

specified four sublots have been completed, the following procedure shall be used to adjust the lot size and number of tests for the lot. Where three sublots have been completed, they shall constitute a lot and acceptance criteria adjusted accordingly. Where one or two sublots have been completed, they shall be incorporated into the next lot or the previous lot, as directed, and the total number of sublots shall be used and acceptance criteria adjusted accordingly.

1.3.13 Areas Defective in Plan Grade or Smoothness

In areas not meeting the specified limits for surface smoothness and plan grade, high areas shall be reduced to attain the required smoothness and grade, except as depth is limited below. High areas shall be reduced either by hand rubbing the freshly finished concrete with a silicon carbide brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 14 days or more old. Rubbing with a silicon carbide brick and water shall be discontinued as soon as contact with the coarse aggregate is made, and all further necessary reduction shall be accomplished by grinding the hardened concrete with a surface-grinding machine after it is 14 days old. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and shall not exceed 1 percent of the total area of any sublot. The depth of grinding shall not exceed 6 mm. All pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified above, shall be removed and replaced in conformance with paragraph REPAIR, REMOVAL, REPLACEMENT OF SLABS. All areas in which rubbing or grinding has been performed will be subject to the thickness tolerances specified in paragraph Thickness. Any rubbing or grinding performed on individual slabs with excessive deficiencies shall be performed at the Contractor's own decision without entitlement to additional compensation if eventual removal of the slab is required.

1.4 ACCEPTABILITY OF WORK

The materials and the pavement itself will be accepted on the basis of tests made by the Contractor's approved commercial laboratory or the supplier's approved laboratory, all as specified herein. The Government may, at its discretion, make check tests to validate the results of the Contractor's testing. If the results of the Government and Contractor tests vary by less than 2.0 percent, of the Government's test results, the results of the Contractor's tests will be used. If the results of the Government and Contractor tests vary by 2.0 percent or more, but less than 4.0 percent, the average of the two will be considered the value to be used. If these vary by 4.0 percent or more, each sampling and testing procedure shall be carefully evaluated and both the Government and the Contractor shall take another series of tests on duplicate samples of material. If these vary by 4.0 percent or more, the results of the tests made by the Government shall be used and the Government will continue check testing of this item on a continuous basis until the two sets of tests agree within less than 4.0 percent on a regular basis. Testing performed by the Government will in no way at any time relieve the Contractor from the specified testing requirements.

1.5 PRECONSTRUCTION TESTING OF MATERIALS

The Contractor shall not be entitled to any additional payment or extension of time because of delays caused by sampling and testing additional

sources, or samples, necessitated by failure of any samples.

1.5.1 Aggregates

Aggregates shall be sampled by the Contractor in the presence of a Government representative. Samples shall be obtained in accordance with COE CRD-C 100 and of the size indicated therein,and shall be representative of the materials to be used for the project. Testing of samples shall be the responsibility of the Contractor and shall be performed by an approved commercial laboratory. Test results shall be submitted 15 working days before commencing paving. No material shall be used unless test results show that it meets all requirements of these specifications.

1.5.2 Chemical Admixtures

The Contractor shall provide satisfactory facilities for ready procurement of adequate test samples. All sampling and testing of an admixture will be by and at the expense of the Contractor. Tests will be conducted with materials proposed for the project. An air-entraining admixture that has been in storage at the project site for longer than 6 months or that has been subjected to freezing will be retested at the expense of the Contractor when considered appropriate and shall be rejected if test results are not satisfactory.

1.5.3 Curing Compound

The Contractor shall provide satisfactory facilities for ready procurement of adequate test samples. The sampling and testing will be by and at the expense of the Contractor.

1.5.4 Epoxy-Resin Material

At least 30 days before the material is used, the Contractor shall submit certified copies of test results showing that the specific lots or batches from which the material will be furnished to this project have been tested by the manufacturer and that the material conforms to the requirements of these specifications. When epoxy resin arrives at the job site, the Contractor shall assist the Government to sample the material. The Government will test the sample or will retain it in storage for possible future testing, as considered appropriate.

1.5.5 Cements and Pozzolans

Preconstruction sampling and testing of cementand pozzolanshall conform to the requirements specified for sampling and testing during construction except that test results showing that each material meets specification requirements shall be available at least 15 days before start of paving operations.

1.6 TESTING BY CONTRACTOR DURING CONSTRUCTION

1.6.1 General

During construction, the Contractor shall be responsible for sampling and testing aggregates, cementitious materials (cement and pozzolan), and concrete to determine compliance with the specifications. All sampling and testing shall be performed by an approved commercial laboratory, or for cementitious materials, the manufacturer's laboratory. Samples of

aggregate shall be obtained at the weigh hopper. Samples of concrete shall be obtained at the point of delivery to the paver. The Government will sample and test concrete and ingredient materials as considered appropriate. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Testing by the Government will in no way relieve the Contractor of the specified testing requirements.

1.6.2 Cementitious Materials

Cement and pozzolan will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports showing that the material in each shipment meets the requirements of the specification under which it is furnished. No cementitious material shall be used until notice of acceptance has been given by the Contracting Officer. Cementitious material may be subjected to check testing by the Government from samples obtained at the mill, at transfer points, or at the project site.

1.7 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment; GA.

a. Details and data on the batching and mixing plant prior to plant assembly including manufacturer's literature showing that the equipment meets all requirements specified herein.

b. A description of the equipment proposed for transporting concrete mixture from the central mixing plant to the paving equipment at least 7 days prior to start of paving unless otherwise specified.

c. At the time the materials are furnished for the mixture proportioning study, a description of the equipment proposed for the placing of the concrete mixture, method of control, and manufacturer's literature on the paver and finisher, together with the manufacturer's written instructions on adjustments and operating procedures necessary to assure a tight, smooth surface on the concrete pavement, free of tears and other surface imperfections, including excessive paste on the surface. The literature shall show that the equipment meets all details of these specifications.

Work Plan; GA.

a. A description of the placing and protection methods proposed prior to construction of the test section, if concrete is to be placed in or exposed to hot or cold weather conditions.

b. A detailed plan of the proposed paving pattern showing all planned construction joints. No deviation from the jointing pattern shown on the drawings shall be made without written approval of the Ft

Worth District Military Design Branch.

c. Data on the curing media and methods to be used.

SD-08 Statements

Samples for Mixture Proportioning Studies; GA.

The results of the Contractor's mixture proportioning studies along with a statement giving the maximum nominal coarse aggregate size and the proportions of all ingredients that will be used in the manufacture of concrete at least 30 days prior to commencing concrete placing operations. Aggregate quantities shall be based on the mass in a saturated surface dry condition. The statement shall be accompanied by test results from an independent commercial testing laboratory, inspected by the Government, and approved in writing, showing that mixture proportioning studies have been made with materials proposed for the project and that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the mixture proportions without additional tests to show that the quality of the concrete is satisfactory.

SD-09 Reports

Sampling and Testing; GA.

Certified copies of laboratory test reports, including all test data, for cement, pozzolan, aggregate, admixtures, and curing compound proposed for use on this project. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials. No material shall be used until notice of acceptance has been given. Materials may be subjected to check testing by the Government from samples obtained at the manufacturer, at transfer points, or at the project site.

SD-18 Records

Delivery, Storage, and Handling of Materials; FIO.

Copies of waybills or delivery tickets for cementitious material during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all cementitious material used in the construction.

1.8 QUALIFICATIONS

All Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) Certified Workmen in one of the following grades (or shall have approved written evidence of having completed similar qualification programs):

Concrete Field Testing Technician, Grade I
Concrete Laboratory Testing Technician, Grade I or II
Concrete Construction Inspector, Level II

The foreman or lead journeyman of the finishing crew shall have similar qualification for ACI Concrete Flatwork Technician/Finisher, or equal. Written documentation shall be furnished for each workman in the above

groups.

1.9 TEST SECTION

At least 10 days but not more than 60 days prior to construction of the concrete pavement, a test section shall be constructed as part of the production paving area at an outer edge and as approved by the Contracting Officer. The test section will be allowed to remain in place, if all specification requirements are met and will be paid for as part of the production pavement. There will be no separate payment for the test section or sections and the cost of the materials, and the construction will be considered a subsidiary cost of constructing the project. The Contractor shall notify the Contracting Officer at least 5 days in advance of the date of test section construction. The test section shall consist of not less than two adjacent paving lanes each at least 100 m long and shall be constructed to the thickness as shown on the drawings. The lane width of each paving lane shall be the same as that required for use in the project. The test section shall contain at least one longitudinal construction joint and one transverse construction joint. If keyed or doweled longitudinal construction joints are required in any of the production pavements, they shall be used throughout the test section. If both keys and dowels are required, each shall be used in half of the test section. Two separate days shall be used for construction of the test section. The Contractor shall use the test section to develop and demonstrate to the satisfaction of the Contracting Officer the proposed techniques of mixing, hauling, placing, consolidating, finishing, curing, start-up procedures, testing methods, plant operations, and the preparation of the construction joints. Variations in mixture proportions other than water shall be made as required herein The mixing plant shall be operated and calibrated prior to placing the test section. The Contractor shall use the same equipment, materials, and construction techniques on the test section as will be used in all subsequent work. Base course preparation, concrete production, placing, consolidating, curing, construction of joints, and all testing shall be in accordance with applicable provisions of this specification. The Contractor shall construct the test section meeting all specification requirements and being acceptable to the Contracting Officer in all aspects, including surface texture. Failure to construct an acceptable test section will necessitate construction of additional test sections at no additional cost to the Government. Test sections allowed to be constructed as part of the production paving which do not meet specification requirements shall be removed at the Contractor's expense. Any test sections unacceptable to the Contracting Officer shall be removed at the Contractor's expense. If the Contractor proposes to use slipform paving and is unable to construct an acceptable test section, or if the slipform paving equipment and procedures are found to be unable to produce acceptable pavement at any time, the slipform paving equipment shall be removed from the job and the construction completed using stationary side forms and equipment compatible with them. The Contractor shall provide four cores at least 150 mm diameter and full depthfrom points selected in the test section by the Government, 5 days after completion of the test section. The Contractor shall deliver the cylinders for inspection and testing, as considered appropriate. Production paving may be started immediately after approval of the test section.

1.10 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.10.1 Bulk Cementitious Materials

All cementitious material shall be furnished in bulk. The temperature of the cementitious material, as delivered to storage at the site, shall not exceed 65 degrees C.

1.10.1.1 Transportation

When bulk cementitious material is not unloaded from primary carriers directly into weather-tight hoppers at the batching plant, transportation from the railhead, mill, or intermediate storage to the batching plant shall be accomplished in adequately designed weather-tight trucks, conveyors, or other means that will protect the cementitious material from exposure to moisture.

1.10.1.2 Storage Requirements

Immediately upon receipt at the site of the work, cementitious materials shall be stored in a dry and properly ventilated structure. All storage facilities shall be subject to approval and shall allow easy access for inspection and identification. Sufficient cementitious materials shall be in storage to sustain continuous operation of the concrete mixing plant while the pavement is being placed. To prevent cement from becoming unduly aged after delivery, any cement that has been stored at the site for 60 days or more shall be used before using cement of lesser age.

1.10.1.3 Separation of Materials

Separate facilities shall be provided which will prevent any intermixing during unloading, transporting, storing, and handling of each type of cementitious material.

1.10.2 Aggregate Materials

1.10.2.1 Storage

Aggregate shall be stored at the site of the batching and mixing plant avoiding breakage, segregation, or contamination by foreign materials. Each size of aggregate from each source shall be stored separately in free-draining stockpiles. Fine aggregate and the smallest size coarse aggregate shall remain in free-draining storage for at least 24 hours immediately prior to use. Sufficient aggregate shall be maintained at the site at all times to permit continuous uninterrupted operation of the mixing plant at the time concrete pavement is being placed.

1.10.2.2 Handling

Aggregate shall be handled avoiding segregation or degradation. Vehicles used for stockpiling or moving aggregate shall be kept clean of foreign materials. Tracked equipment shall not be allowed on coarse aggregate stockpiles. Stockpiles shall be built up and worked avoiding segregation in the piles and preventing different sizes of aggregate from being mixed during storage or batching. Aggregate shall not be stored directly on ground unless a sacrificial layer is left undisturbed and unused.

1.10.3 Other Materials

Reinforcing bars and accessories shall be stored above the ground on platforms, skids, or other supports. Other materials shall be stored

avoiding contamination and deterioration. Chemical admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements. The Contractor shall ensure that materials can be accurately identified after bundles or containers are opened.

1.11 EQUIPMENT

All plant, equipment, tools, and machines used in the work shall be maintained in satisfactory working conditions at all times.

1.11.1 Batching and Mixing Plant

1.11.1.1 Location of Batching and Mixing Plant

The batching and mixing plant may be located on the project site as indicated on the drawings or off Government remises no more than 15 minutes haul time from the placing site. There shall be operable telephonic or radio communication between the batching plant and the placing site at all times concreting is taking place.

1.11.1.2 Type and Capacity of Batching and Mixing Plant

The batching and mixing plant shall be a stationary-type plant. The plant shall be designed and operated to produce concrete within the specified tolerances, and shall have a capacity of at least 200 cubic meters per hour. The batching plant shall conform to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required.

1.11.1.3 Equipment Requirements

The batching controls shall be either semiautomatic or automatic. Semiautomatic batching system shall be provided with interlocks. Separate bins or compartments shall be provided for each size group of aggregate and each cementitious material. Aggregates shall be weighed either in separate weigh batchers with individual scales or cumulatively in one weigh batcher on one scale, provided the fine aggregate is weighed first. Aggregate shall not be weighed in the same batcher with cementitious material. If both cement and pozzolan are used, they may be batched cumulatively, provided portland cement is batched first. Water shall not be weighed or measured cumulatively with another ingredient. Water batcher filling and discharging valves shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. An accurate mechanical device for measuring and dispensing each chemical admixture shall be provided. Each dispenser shall be interlocked with the batching cycle and discharged automatically to obtain uniform distribution throughout the batch in the specified mixing period. Different chemical admixtures shall not be combined before introduction in water and cement. The plant shall be arranged to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment.

1.11.1.4 Scales

Adequate facilities shall be provided for the accurate measurement and control of each of the materials entering each batch of concrete. The

weighing equipment shall conform to the applicable requirements of NIST HB 44, except that the accuracy shall be within 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring device. Each weighing unit shall include a visible springless dial, which shall indicate the scale load at all stages of the weighing operation or shall include a beam scale with a beam balance indicator that will show the scale in balance at zero load and at any beam setting. The indicator shall have an over and under travel equal to at least 5 percent of the capacity of the beam. Approved electronic digital indicators and load cells may also be used. The weighing equipment shall be arranged to allow the concrete plant operator to conveniently observe the dials or indicators.

1.11.1.5 Batching Tolerances

The following tolerances shall apply.

Materials	Percentage of Required Mass
Cement (and Pozzolan)	plus or minus 1
Aggregate	plus or minus 2
Water	plus or minus 1
Admixture	plus or minus 3

For volumetric batching equipment for water and admixtures, the above numeric tolerances shall apply to the required volume of material being batched. Concentrated admixtures shall be uniformly diluted, if necessary, to provide sufficient volume per batch to ensure that the batchers will consistently operate within the above tolerance.

1.11.1.6 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture contents of the aggregates and to change the quantities of the materials being batched. An electric moisture meter complying with the provisions of COE CRD-C 143 shall be provided for measuring of moisture in the fine aggregate. The sensing element shall be arranged so that measurement is made near the batcher charging gate of the fine aggregate bin or in the fine aggregate batcher.

1.11.1.7 Recorders

A graphic or digital recorder conforming to the requirements of NRMCA CPMB 100 shall be furnished and kept operational at the batching plant.

1.11.2 Concrete Mixers

Mixers shall be stationary mixers. Mixers shall be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. The mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Mixer blades or paddles shall be replaced when worn down more than 10 percent of their depth when

compared with the manufacturer's dimension for new blades or paddles.

1.11.2.1 Stationary, Central Plant, Mixers

Stationary mixers shall be drum mixers of tilting type. Mixers shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed.

1.11.2.2 Truck Mixers

The only truck mixers used for transporting paving concrete shall be those designed with extra large blading and rear opening specifically for low-slump paving concrete. Truck mixers, the mixing of concrete therein, and concrete uniformity and testing thereof shall conform to the requirements of ASTM C 94. A truck mixer may be used to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be equipped with two counters which will show the number of revolutions at mixing speed and the number of revolutions at agitating speed. Concrete first partially mixed in a concrete plant mixer (shrink-mixed) a minimum time, as required to combine the ingredients, shall then be completely mixed in a truck mixer. The number of revolutions between 70 to 100 for truck-mixed concrete and the number of revolutions for shrink-mixed concrete shall be determined by uniformity tests as specified in ASTM C 94 and in requirements for mixer performance stated in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL. If requirements for the uniformity of concrete are not met with 100 revolutions of mixing after all ingredients including water are in the truck mixer drum, the mixer shall not be used until the condition is corrected. Additional revolutions beyond the number determined to produce the required uniformity shall be at the designated agitating speed. Water shall not be added after the initial introduction of mixing water except, when on arrival at the job site, the slump is less than specified and the water-cement ratio is less than that given as a maximum in the approved mixture. Additional water may be added to bring the slump within the specified range provided the approved water-cement ratio is not exceeded. Water shall be injected into the head of the mixer (end opposite the discharge opening) drum under pressure, and the drum or blades shall be turned a minimum of 30 additional revolutions at mixing speed. Water shall not be added to the batch at any later time.

1.11.2.3 Mixing Time and Uniformity

a. Stationary Mixers: For stationary mixers, before uniformity data are available, the mixing time for each batch after all solid materials are in the mixer, provided that all of the mixing water is introduced before one-fourth of the mixing time has elapsed, shall be 1 minute for mixers having a capacity of 0.75 cubic meter.
For mixers of greater capacity, this minimum time shall be increased 20 seconds for each additional cubic meter or fraction thereof. After results of uniformity tests are available, the mixing time may be reduced to the minimum time required to meet uniformity requirements; but if uniformity requirements are not being met, the mixing time shall be increased as directed. Mixer performance tests at new mixing times shall be performed immediately after any change in mixing time. When regular testing is performed, the concrete shall meet the limits of any five of the six uniformity requirements listed in Table 4, below. When abbreviated testing is performed, the concrete shall meet only those requirements listed for abbreviated testing. The concrete

proportions used for uniformity tests shall be as used on the project. Regular testing shall consist of performing all six tests on three batches of concrete. The range for regular testing shall be the average of the ranges of the three batches. Abbreviated testing shall consist of performing the three required tests on a single batch of concrete. The range for abbreviated testing shall be the range for one batch. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, etc., the results of tests on one of the mixers shall apply to the others, subject to the approval of the Contracting Officer. All mixer performance (uniformity) testing shall be performed by the Contractor in accordance with COE CRD-C 55 and with paragraph titled TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL.

TABLE 4
UNIFORMITY REQUIREMENTS--STATIONARY MIXERS

Parameter	Regular Tests Allowable Maximum Range for Average of 3 Batches	Abbreviated Tests Allowable Maximum Range for 1 Batch
Unit weight of air-free mortar, kg/cubic meter	32	32
Air content, percent	1.0	--
Slump, mm	25	--
Coarse aggregate, percent	6.0	6.0
Compressive strength at 7 days, percent	10.0	10.0
Water content, percent	1.5	--

b. Truck Mixers: Mixer performance (uniformity) tests for truck mixers shall be made by the Contractor in accordance with ASTM C 94.

1.11.3 Transporting Equipment

Concrete shall be transported to the paving site in nonagitating equipment conforming to ASTM C 94 in approved truck mixers designed with extra large blading and rear opening specifically for low slump concrete or in approved agitators. All transporting equipment shall be designed and operated to deliver and discharge the required concrete mixture completely without segregation.

1.11.4 Paver-Finisher

The paver-finisher shall be a heavy-duty, self-propelled machine designed specifically for paving and finishing high quality pavement. The paver-finisher shall weigh at least 3280 kg per m of lane width, and shall be powered by an engine having at least 15,000 W per meter of lane width. The paver-finisher shall spread, consolidate, and shape the plastic concrete to the desired cross section in one pass. The mechanisms for

forming the pavement shall be easily adjustable in width and thickness and for required crown. In addition to other spreaders required by paragraph Transfer and Spreading Equipment, the paver-finisher shall be equipped with a full width knock-down auger or paddle mechanism, capable of operating in both directions, which will evenly spread the fresh concrete in front of the screed or extrusion plate. Immersion vibrators shall be gang mounted at the front of the paver on a frame equipped with suitable controls so that all vibrators can be operated at any desired depth within the slab or completely withdrawn from the concrete, as required. The vibrators shall be automatically controlled so that they will be immediately stopped as forward motion of the paver ceases. The spacing of the immersion vibrators across the paving lane shall be as necessary to properly consolidate the concrete, but the clear distance between vibrators shall not exceed 750 mm. Spud vibrators shall operate at a frequency of not less than 135 Hz and an amplitude of not less than 0.75 mm and tube vibrators at a frequency of not less than 80 Hz and an amplitude of not less than 0.75 mm, as determined by COE CRD-C 521. The paver-finisher shall be equipped with a transversely oscillating screed or an extrusion plate to shape, compact, and smooth the surface and shall so finish the surface that no significant amount of hand finishing, except use of cutting straightedges, is required. The screed or extrusion plate shall be constructed to provide adjustment for crown in the pavement. The entire machine shall provide adjustment for variation in lane width or thickness and to prevent more than 200 mm of the screed or extrusion plate extending over previously placed concrete on either end when paving fill-in lanes. Machines that cause displacement of properly installed forms or cause ruts or indentations in the prepared underlying materials and machines that cause frequent delays due to mechanical failures shall be replaced as directed.

1.11.4.1 Paver-Finisher with Fixed Forms

The paver-finisher shall be equipped with wheels designed to keep it aligned with the forms and to spread the load so as to prevent deformation of the forms.

1.11.4.2 Slipform Paver-Finisher

The slipform paver-finisher shall be automatically controlled and crawler mounted with four padded tracks so as to be completely stable under all operating conditions. The paver-finisher shall finish the surface and edges so that no edge slump beyond allowable tolerance occurs. Horizontal alignment shall be electronically referenced to a taut wire guideline. Vertical alignment shall be electronically referenced on both sides of the paver to a taut wire guideline, to an approved laser control system, or, only where permitted by paragraph Slipform Paving, to a ski operating on a completed lane. Suitable moving side forms shall be provided that are adjustable and will produce smooth, even edges, perpendicular to the top surface and meeting specification requirements for alignment and freedom from edge slump.

1.11.4.3 Longitudinal Mechanical Float

A longitudinal mechanical float shall be specially designed and manufactured to smooth and finish the pavement surface without working excess paste to the surface. It shall be rigidly attached to the rear of the paver-finisher or to a separate self-propelled frame spanning the paving lane. The float plate shall be at least 1.5 m long by 200 mm wide and shall automatically be oscillated in the longitudinal direction while

slowly moving from edge to edge of the paving lane, with the float plate in contact with the surface at all times.

1.11.4.4 Nonrotating Pipe Float

A pipe float if used, shall be a nonrotating pipe 150 to 250 mm in diameter and sufficiently long to span the full paving width when oriented at an angle of approximately 1.05 rad with the centerline. The pipe float shall be mounted on a self-propelled frame that spans the paving lane. No means of applying water to the surface shall be incorporated in the pipe float.

1.11.4.5 Other Types of Finishing Equipment

Clary screeds or other rotating tube floats, or bridge deck finishers, shall not be allowed on the project. Concrete finishing equipment of types other than specified above may be demonstrated on a test section outside the production pavement if approved in writing. If the Contracting Officer's representative decides from evaluation of the test section that the equipment is better than the specified finishing equipment, its use will be permitted as long as it continues to perform better than the specified equipment.

1.11.5 Curing Equipment

Equipment for applying membrane-forming curing compound shall be mounted on a self-propelled frame that spans the paving lane. The reservoir for curing compound shall be constantly mechanically (not air) agitated during operation and shall contain means for completely draining the reservoir. The spraying system shall consist of a mechanically powered pump which will maintain constant pressure during operation, an operable pressure gauge, and either a series of spray nozzles evenly spaced across the lane to give uniformly overlapping coverage or a single spray nozzle which is mounted on a carriage which automatically traverses the lane width at a speed correlated with the forward movement of the overall frame. All spray nozzles shall be protected with wind screens. Any hand-operated sprayers allowed by paragraph Membrane Curing shall be compressed air supplied by a mechanical air compressor. If the curing machine fails to apply an even coating of compound at the specified rate, it shall immediately be replaced.

1.11.6 Texturing Equipment

Texturing equipment shall be as specified below. Before use, the texturing equipment shall be demonstrated on a test section, and the equipment shall be modified as necessary to produce the texture directed.

1.11.6.1 Fabric Drag

A fabric drag shall consist of a piece of material as long as the lane width securely attached to a separate wheel mounted frame spanning the paving lane or to one of the other similar pieces of equipment. Width of the material shall provide 300 to 450 mm dragging flat on the pavement surface. Length shall be at least equal to the width of the slab plus 600 mm. The material shall be clean, reasonably new burlap, completely saturated with water before attachment to the frame and always resaturated before start of use and kept clean and saturated during use. Burlap shall conform to AASHTO M 182, Class 3 or 4.

1.11.7 Sawing Equipment

Equipment for sawing joints and for other similar sawing of concrete shall be standard diamond-type concrete saws mounted on a wheeled chassis which can be easily guided to follow the required alignment. Blades shall be diamond tipped. If demonstrated to operate properly, abrasive blades may be used. Wheel saws shall be saws with large diameter tungsten carbide tipped blades mounted on a heavy-duty chassis which will produce a saw kerf at least 40 mm wide. All saws shall be capable of sawing to the full depth required.

1.11.8 Straightedge

The Contractor shall furnish and maintain at the job site, in good condition, one 4 m straightedge for each paving train for testing the hardened portland cement concrete surfaces. These straightedges shall be constructed of aluminum or magnesium alloy and shall have blades of box or box-girder cross section with flat bottom, adequately reinforced to insure rigidity and accuracy. Straightedges shall have handles for operation on the pavement.

1.11.9 Profilograph

The Contractor shall furnish a 7.6 m profilograph for testing the finished pavement surface. The profilograph shall produce a record on tape of the results of testing the pavement surface and shall automatically mark the Profile Index of each section tested as well as indicate and measure each "must grind" point, all in accordance with CDT Test 526 and as required by paragraph Surface Smoothness.

PART 2 PRODUCTS

2.1 CEMENTITIOUS MATERIALS

Cementitious materials shall be portland cement, or portland-pozzolan cement, or only portland cement in combination with pozzolan and shall conform to appropriate specifications listed below. Temperature of cementitious materials as supplied to the project shall not exceed 65 degrees C.

2.1.1 Portland Cement

Portland cement shall conform to ASTM C 150, Type I or II, low-alkali including false set requirements.

2.1.2 High-Early-Strength Portland Cement

High-early-strength cement shall conform to ASTM C 150, Type III with C3A limited to 5percent, low-alkali.

2.1.3 Blended Cements

Blended cement shall conform to ASTM C 595, Type IP .

2.1.4 Pozzolan (Fly Ash and Silica Fume)

2.1.4.1 Fly Ash

Fly ash shall conform to ASTM C 618, Class F, with the optional

requirements for multiple factor, drying shrinkage, and uniformity from Table 2A in ASTM C 618. The fly ash shall meet the optional requirements on limits of alkalies in Table IA of ASTM C 618, or shall meet the optional limit on mortar expansion from Table IIA of ASTM C 618. Fly ash shall be used only at a rate between 15 and 35 percent of the total cementitious material by mass.

2.2 AGGREGATES

2.2.1 Coarse Aggregate

Coarse aggregate shall have a satisfactory service record of at least 5 years successful service in three paving projects or, if a new source is used.

2.2.1.1 Material Composition

Coarse aggregate shall consist of crushed gravel or crushed stone, . Crushed gravel shall contain not less than 75 percent of crushed particles by mass in each sieve size, as determined by COE CRD-C 171.

2.2.1.2 Quality

Aggregates as delivered to the mixers shall consist of clean, hard, uncoated particles meeting the requirements of ASTM C 33 and other requirements specified herein.

2.2.1.3 Particle Shape Characteristics

Particles of the coarse aggregate shall be generally spherical or cubical in shape. The quantity of flat and elongated particles in any size group shall not exceed 20 percent by weight as determined by COE CRD-C 119. A flat particle is defined as one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3.

2.2.1.4 Size and Grading

The nominal maximum size of the coarse aggregate shall be 38 mm. When the nominal maximum size is greater than 25 mm, the aggregates shall be furnished in two size groups as follows:

Nominal Maximum Size mm	Size Group
19	ASTM C 33 --No. 67 (4.75 to 19 mm)
37.5	ASTM C 33 --No. 4 (19 to 37.5 mm)

The grading of the coarse aggregate within the separated size groups shall conform to the requirements of ASTM C 33, Sizes 67 and 4 as delivered to the mixer.

2.2.1.5 Resistance to Freezing and Thawing

Coarse aggregate not having a satisfactory demonstrable service record shall have a durability factor of 50 or more when subjected to freezing and thawing in concrete in accordance with COE CRD-C 114.

2.2.1.6 Resistance to Abrasion

Coarse aggregate shall not show more than 40 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C 131.

2.2.1.7 Deleterious Material

The amount of deleterious material in each sieve size of coarse aggregate shall not exceed the limits in the following table when tested as indicated.

LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE
Percentage by Mass

Clay lumps and friable particles (ASTM C 142)	2.0
Material finer than 0.075 mm (No. 200 sieve) (ASTM C 117)	1.0
Lightweight particles (ASTM C 123)	1.0
Other soft particles (ASTM C 330)	2.0

The total of all deleterious substances shall not exceed 5.0 percent of the mass of the aggregate. The percentage of material finer than the 0.075 mm sieve shall not be included in this total. The limit for material finer than the 0.075 mm sieve will be increased to 1.5 percent for crushed aggregates consisting of crusher dust that is essentially free from clay or shale. The separation medium for lightweight particles shall have a density of 2.0 Mg/cubic meter (Sp. Gr. 2.0). This limit does not apply to coarse aggregate manufactured from blast-furnace slag unless contamination is evident.

2.2.2 Fine Aggregate

Fine aggregate shall have a service record of at least 5 years satisfactory service in three paving projects or, if a new source is used, shall meet the requirements for resistance to freezing and thawing.

2.2.2.1 Composition

Fine aggregate shall consist of natural sand, manufactured sand, or a combination of the two, and shall be composed of clean, hard, durable particles. Irrespective of the source from which it is obtained, all fine aggregate shall be composed of clean, hard, durable particles meeting the requirements of ASTM C 33. Each type of fine aggregate shall be stockpiled and batched separately. Any degree of contamination will be cause for the rejection of the entire stockpile.

2.2.2.2 Particle Shape

Particles of the fine aggregate shall be generally spherical or cubical in shape.

2.2.2.3 Grading

Grading of the fine aggregate, as delivered to the mixer, shall conform to the requirements of ASTM C 33. In addition, the fine aggregate, as delivered to the mixer, shall have a fineness modulus of not less than 2.50 nor more than 3.00. The grading of the fine aggregate also shall be controlled so that the fineness moduli of at least nine of every set of ten consecutive samples of the fine aggregate, as delivered to the mixer, will not vary more than 0.15 from the average fineness moduli of all samples previously taken. The fineness modulus shall be determined by COE CRD-C 104.

2.2.2.4 Deleterious Material

The amount of deleterious material in the fine aggregate shall not exceed the following limits by mass:

Material	Percentage by Mass
Clay lumps and friable particles ASTM C 142	1.0
Material finer than 0.075 mm (No. 200 sieve) ASTM C 117	3.0
Lightweight particles ASTM C 123 using a medium with a density of 2.0 Mg/cubic meter (Sp. Gr. of 2.0))	0.5
Total of all above	3.0

2.2.2.5 Resistance to Freezing and Thawing

Fine aggregate not having a satisfactory demonstrable service record shall have a durability factor of 50 or more when subjected to freezing and thawing in concrete in accordance with COE CRD-C 114.

2.3 CHEMICAL ADMIXTURES

2.3.1 Air-Entraining Admixtures

The air-entraining admixture shall conform to ASTM C 260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entraining admixture shall be in a solution of suitable concentration for field use.

2.3.2 Accelerator

An accelerator shall be used only when specified in paragraph SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES and shall not be used to reduce the amount of cementitious material used. Accelerator shall conform to ASTM C 494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

2.3.3 Retarder

A retarding admixture shall meet the requirements of ASTM C 494, Type B, except that the 6-month and 1-year compressive strength tests are waived. The use of the admixture is at the option of the Contractor, but shall not be used to reduce the amount of cementitious material.

2.3.4 Water-Reducer

A water-reducing admixture shall meet the requirements of ASTM C 494, Type A or D except that the 6-month and 1-year compressive strength tests are waived. The admixture may be added to the concrete mixture only when its use is approved or directed, and only when it has been used in mixture proportioning studies to arrive at approved mixture proportions.

2.4 CURING MATERIALS

2.4.1 Membrane Forming Curing Compound

Membrane forming curing compound shall be a white pigmented compound conforming to COE CRD-C 300.

2.4.2 Burlap

Burlap used for curing shall conform to AASHTO M 182, Class 3 or 4. Materials shall be new or shall be clean materials never used for anything other than curing concrete.

2.5 WATER

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water may be used if it meets the requirements of COE CRD-C 400.

2.6 JOINT MATERIALS

2.6.1 Expansion Joint Material

Expansion joint filler shall be a preformed material conforming to ASTM D 1752 Type I or II. Expansion joint filler shall be 20 mm thick.

2.7 REINFORCING

All reinforcement shall be free from loose, flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce the bond with concrete. Removal of thin powdery rust and tight rust is not required. However, reinforcing steel which is rusted to the extent that it does not conform to the required dimensions or mechanical properties shall not be used.

2.7.1 Reinforcing Bars and Bar Mats

Reinforcing bars shall conform to ASTM A 615/A 615M, billet-steel; ASTM A 616/A 616M, rail-steel; or ASTM A 617/A 617M, axle-steel, Grade 60, size as shown on the drawings. Bar mats shall conform to ASTM A 184/A 184M. The bar members shall be billet steel.

2.7.2 Welded Wire Fabric

Welded steel wire fabric shall conform to ASTM A 185.

2.7.3 Deformed Wire Fabric

Welded deformed steel wire fabric shall conform to ASTM A 497.

2.8 DOWELS AND TIE BARS

2.8.1 Dowels

Dowels shall be single piece bars fabricated or cut to length at the shop or mill before delivery to the site. Dowels shall be free of loose, flaky rust and loose scale and shall be clean and straight. Dowels may be sheared to length provided that the deformation from true shape caused by shearing does not exceed 1 mm on the diameter of the dowel and does not extend more than 1 mm from the end of the dowel. Dowels shall be plain (non-deformed) steel bars conforming to ASTM A 615/A 615M, Grade 40 or 60; ASTM A 616/A 616M, Grade 50 or 60; or ASTM A 617/A 617M, Grade 40 or 60; or shall be steel pipe conforming to ASTM A 53, extra strong, as indicated. If split dowels are proposed for use, a complete description of the materials and installation procedures shall be submitted for approval at least 15 days before start of construction.. At least one half of the smooth dowel shall be epoxy-coated and shall conform to ASTM A 775

2.8.2 Tie Bars

Tie bars shall be deformed steel bars conforming to ASTM A 615/A 615M, ASTM A 616/A 616M, or ASTM A 617/A 617M, Grade 60, and of the sizes and dimensions indicated. Deformed rail steel bars and high-strength billet or axle steel bars, Grade 60 or higher, shall not be used for bars that are bent and straightened during construction.

2.9 EPOXY RESIN

All epoxy-resin materials shall be two-component materials conforming to the requirements of ASTM C 881, Class as appropriate for each application temperature to be encountered, except that in addition, the materials shall meet the following requirements:

a. Material for use for embedding dowels and anchor bolts shall be Type IV, Grade 3.

b. Material for use as patching materials for complete filling of spalls, wide cracks, and other voids and for use in preparing epoxy resin mortar shall be Type III, Grade as approved.

c. Material for use for injecting cracks shall be Type IV, Grade 1.

d. Material for bonding freshly mixed portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete shall be Type V, Grade as approved.

2.10 SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES

2.10.1 Specified Flexural Strength

Specified flexural strength, R, for concrete is 4.48 MPa at 28 day, as determined by tests made in accordance with ASTM C 78 on beams fabricated and cured in accordance with ASTM C 192/C 192M Maximum allowable water-cementitious material ratio is 0.45. The water-cementitious material

ratio will be the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus pozzolan by the mass equivalency method described in ACI 211.1. The concrete shall be air-entrained with a total air content of 5 plus or minus 1.0 percentage points, at the point of placement. Air content shall be determined in accordance with ASTM C 231. The maximum allowable slump of the concrete at the point of placement shall be [AM #1] 75 mm for pavement constructed with fixed forms. For slipformed pavement, at the start of the project, the Contractor shall select a maximum allowable slump which will produce in-place pavement meeting the specified tolerances for control of edge slump.

2.10.2 Concrete Temperature

The temperature of the concrete as delivered shall conform to the requirements of paragraphs, Paving in Hot Weather and Paving in Cold Weather. Temperature of concrete shall be determined in accordance with ASTM C 1064.

2.10.3 Concrete Strength for Final Acceptance

The strength of the concrete will be considered acceptable when the average 28-day flexural strengths for each lot are above the 'Specified Flexural Strength' and no individual set (2 beams per sublot) in the lot are 170 kPa or more below the 'Specified Flexural Strength'. If any lot or sublot, respectively, fails to meet the above criteria, the lot or sublot shall be removed and replaced at no additional cost to the Government.

2.11 MIXTURE PROPORTIONS BY CONTRACTOR

2.11.1 Composition

Concrete shall be composed of cementitious material, water, fine and coarse aggregates, and admixtures. The cementitious material shall be portland cement, or blended cementor only portland cement in combination with pozzolan. Pozzolan, if used, shall consist of not less than 15 percent of the cementitious material by mass and not more than [AM #1] 25 percent. The total portland cement content shall be at least 306.8 kg/cubic meter. Admixtures shall consist of air entraining admixture and may also include, as approvedaccelerator retarderwater-reducing admixture. If water-reducer is used, it shall be used only at the dosage determined during mixture proportioning studies. High range water-reducing admixtures and admixtures to produce flowable concrete shall not be used.

2.11.2 Concrete Proportioning Studies, Pavement Concrete

Trial design batches, mixture proportioning studies, and testing requirements shall be the responsibility of the Contractor. Mixture proportioning studies shall be performed by a commercial laboratory, inspected by the Government, and approved in writing. The laboratory performing the mixture proportioning shall conform with ASTM C 1077. Strength requirements during mixture proportioning studies shall be based on flexural strength as determined by test specimens fabricated in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 78. Samples of all materials used in mixture proportioning studies shall be representative of those proposed for use on the project and shall be accompanied by the manufacturer's or producer's test reports indicating compliance with these specifications. Trial mixtures having proportions,

slumps, and air content suitable for the work shall be based on methodology described in ACI 211.1, modified as necessary to accommodate flexural strength.

2.11.2.1 Water-Cement Ratio

At least three different water-cement ratios, which will produce a range of strength encompassing that required on the project, shall be used. The maximum allowable water-cement ratio required in paragraph Maximum Water-Cement Ratio will be the equivalent water-cement ratio as determined by conversion from the mass ratio of water to cement plus pozzolan by the weight equivalency method as described in ACI 211.1. If pozzolan is used in the concrete mixture, the minimum pozzolan content shall be 15 percent by mass of the total cementitious material, and the maximum shall be [AM #1] 25 percent. Laboratory trial mixtures shall be proportioned for maximum permitted slump and air content.

2.11.2.2 Trial Mixture Studies

Separate sets of trial mixture studies shall be made for each combination of cementitious materials and each combination of admixtures proposed for use. No combination of either shall be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerator or a retarder may be used without separate trial mixture study. Separate trial mixture studies shall also be made for concrete for any placing method proposed which requires special properties. The temperature of concrete in each trial batch shall be reported. Each mixture shall be designed to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding. Concrete proportioning studies shall be performed using the following procedures:

2.11.2.3 Mixture Proportioning for 28-day Flexural Strength

The following step by step procedure shall be followed:

a. Fabricate all beams for each mixture from the same batch or blend of batches. Fabricate and cure all beams in accordance with ASTM C 192/C 192M, using 152 x 152 mm beams .

b. Test beams in accordance with ASTM C 78.

c. Fabricate and cure test beams from each mixture for 7, 14, 28 and -day flexural tests; 6 beams to be tested per age.

d. Using the average strength for each w/c at each age, plot all results from each of the three mixtures on separate graphs for w/c versus:

7-day flexural strength
14-day flexural strength
28-day flexural strength

e. From these graphs select a w/c that will produce a mixture giving a 28-day flexural strength equal to the required strength determined in accordance with paragraph "Average Flexural Strength Required for Mixtures".

f. No concrete pavement shall be placed until the Contracting Officer has approved the Contractor's mixture proportions.

2.11.3 Contractor Quality Control for Average Flexural Strength

The Contractor's day to day production shall be Controlled (CQC) in accordance with the criteria herein, in the following subparagraphs, and in par. 'Concrete Strength Testing for CQC'. This is entirely different from the acceptance requirements of paragragh 'Concrete Strength for Final Acceptance', and it is mandatory that both sets of requirements must be met. If at any time, the 28-day flextural strength, for any lot, is 410 kPa or more below the 'required average 28-day flexural strength', as specified below, the paving operation shall be stopped and the Contractor shall take necessary steps to improve the mixture proportioning, materials, or the batching and mixing to increase the strength. The paving operations shall not recommence until the Contracting Officer has approved the Contractor's Proposed changes in writing.

2.11.3.1 Average Flexural Strength Required for Mixtures

In order to ensure meeting, during production, the strength requirements specified in paragraph SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES, the mixture proportions selected during mixture proportioning studies and used during construction shall produce a required average flexural strength exceeding the specified strength, R, by the amount indicated below. This required average flexural strength, Ra, will be used only for CQC operations as specified in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL and as specified in the previous paragraph. During production, the required Ra shall be adjusted (increased or decreased), as appropriate and as approved, based on the standard deviation of 28-day strengths being attained during paving.

a. From Previous Test Records: Where a concrete production facility has previous test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214.3R. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected, shall represent concrete produced to meet a specified flexural strength or strengths within 1 MPa of the 28-day flexural strength specified for the proposed work, and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two specimens made from the same sample of concrete and tested at 28 days. Required average flexural strength, Ra, used as the basis for selection of concrete proportions shall be the value from the equation that follows, using the standard deviation as determined above:

Ra = R + 1.34S

Where: S = standard deviation

R = specified flexural strength
Ra = required average flexural strength

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS	MODIFICATION FACTOR FOR STANDARD DEVIATION
15	1.16
20	1.08
25	1.03
30 or more	1.00

b. Without Previous Test Records: When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength, Ra, shall be determined by adding 15 percent to the specified flexural strength, R.

PART 3 EXECUTION

3.1 PREPARATION FOR PAVING

Before commencing paving, the following shall be performed. Surfaces to receive concrete shall be prepared as specified below. If used, forms shall be in place, cleaned, coated, and adequately supported. Any reinforcing steel needed shall be at the paving site. All transporting and transfer equipment shall be ready for use, clean, and free of hardened concrete and foreign material. Equipment for spreading, consolidating, screeding, finishing, and texturing concrete shall be at the paving site, clean and in proper working order. All equipment and material for curing and for protecting concrete from weather or mechanical damage shall be at the paving site, in proper working condition, and in sufficient amount for the entire placement. When hot, windy conditions during paving appear probable, equipment and material shall be at the paving site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

3.2 CONDITIONING OF UNDERLYING MATERIAL

3.2.1 General

The underlying base course material, upon which concrete is to be placed shall be clean, damp, and free from debris, waste concrete or cement, frost, ice, and standing or running water. Prior to setting forms or placement of concrete, the underlying material shall be well drained and shall have been satisfactorily graded and uniformly compacted in accordance with the applicable Section of these specifications. The surface of the base course shall be tested as to crown, elevation, and density in advance of setting forms or of concrete placement using slip-form techniques. High areas shall be trimmed to proper elevation. Low areas shall be filled and compacted to a condition similar to that of surrounding grade, or filled with concrete monolithically with the pavement. Where low areas are filled

with concrete, the areas shall be marked, as approved, and cores for thickness determinations as required by paragraph, Flexural Strength and Thickness shall not be drilled in those areas. Any underlying material disturbed by construction operations shall be reworked and recompacted to specified density immediately in front of the paver. If a slipform paver is permitted and is used, the same underlying material under the paving lane shall be continued beyond the edge of the lane a sufficient distance and shall be thoroughly compacted and true to grade to provide a suitable trackline for the slipform paver and firm support for the edge of the paving lane. Where an open-graded granular base is required under the concrete, the Contractor shall select paving equipment and procedures which will operate properly on the base course without causing displacement or other damage.

3.2.2 Traffic on Underlying Material

After the underlying material has been prepared for concrete placement, no equipment shall be permitted thereon. Subject to specific approval, crossing of the prepared base course at specified intervals for construction purposes may be permitted, provided rutting or indentations do not occur; however, if traffic has been allowed to use the prepared base course, the surface shall be reworked and reprepared to the satisfaction of the Contracting Officer before concrete is placed.

3.3 WEATHER LIMITATIONS

3.3.1 Placement and Protection During Inclement Weather

The Contractor shall not commence placing operations when heavy rain or other damaging weather conditions appear imminent. At all times when placing concrete, the Contractor shall maintain on-site sufficient waterproof cover and means to rapidly place it over all unhardened concrete or concrete that might be damaged by rain. Placement of concrete shall be suspended whenever rain or other damaging weather commences to damage the surface or texture of the placed unhardened concrete, washes cement out of the concrete, or changes the water content of the surface concrete. All unhardened concrete shall be immediately covered and protected from the rain or other damaging weather. Any pavement damaged by rain or other weather shall be completely removed and replaced at the Contractor's expense as specified in paragraph, Repair, Removal, Replacement of Slabs.

3.3.2 Paving in Hot Weather

When the ambient temperature during paving is expected to exceed 32 degrees C, the concrete shall be properly placed and finished in accordance with procedures previously submitted and as specified herein. The concrete temperature at time of delivery to the forms shall not exceed the temperature shown in the table below when measured in accordance with ASTM C 1064. Cooling of the mixing water or aggregates or placing in the cooler part of the day may be required to obtain an adequate placing temperature. An approved retarder may be used to facilitate placing and finishing. Steel forms and reinforcing shall be cooled as approved prior to concrete placement when steel temperatures are greater than 49 degrees C. Transporting and placing equipment shall be cooled or protected if necessary to maintain proper concrete-placing temperature. Concrete shall be placed continuously and rapidly at a rate of not less than 30 m of paving lane per hour. The finished surfaces of the newly laid pavement shall be kept damp by applying a fog spray (mist) with approved spraying

equipment until the pavement is covered by the curing medium. If necessary, wind screens shall be provided to protect the concrete from an evaporation rate in excess of 1 kg/square meter per hour, as determined by method shown in Figure 2.1.5 of ACI 305R.

Maximum Allowable Concrete Placing Temperature

Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature in Degrees C
Greater than 60	33
40-60	30
Less than 40	27

3.3.3 Prevention of Plastic Shrinkage Cracking

During hot weather with low humidity, and particularly with appreciable wind, the Contractor shall develop and institute measures to prevent plastic shrinkage cracks from developing. Particular care shall be taken if plastic shrinkage cracking is potentially imminent and especially if it has developed during a previous placement. Periods of high potential for plastic shrinkage cracking can be anticipated by use of Fig. 2.1.5 of ACI 305R. In addition to the protective measures specified in the previous paragraph, the concrete placement shall be further protected by erecting shades and windbreaks and by applying fog sprays of water, sprinkling, ponding, or wet covering. When such water treatment is stopped, curing procedures shall be immediately commenced. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin as directed, after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry.

3.3.4 Paving in Cold Weather

Special protection measures, as submitted and approved, and as specified herein, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The ambient temperature of the air at the placing site and the temperature of surfaces to receive concrete shall be not less 5 degrees C. However, placement may begin when both the ambient temperature and the temperature of the underlying material are at least 2 degrees C and rising. When the ambient temperature is less than 10 degrees C, the temperature of the concrete when placed shall be not less than 10 degrees C nor more than 25 degrees C. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Upon written approval, chemical admixture conforming to ASTM C 494Type C or E may be used provided it contains no calcium chloride. Calcium chloride shall not be used at any time. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 10 degrees C for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period. Pavement damaged by freezing shall be completely removed and replaced at the Contractor's expense as specified in paragraph REPAIR, REMOVAL, REPLACEMENT OF SLABS.

3.4 CONCRETE PRODUCTION

Batching, mixing, and transporting equipment shall have a capacity sufficient to maintain a continuous, uniform forward movement of the paver of not less than 0.8 m per minute. Concrete shall be deposited in front of the paver within 45 minutes from the time cement has been charged into the mixing drum, except that if the ambient temperature is above 32 degrees C, the time shall be reduced to 30 minutes. No water shall be added to the concrete after it is batched except that, if truck mixers are permitted, water may be added at the paving site to adjust the slump as approved, provided the maximum allowable w/c is not exceeded. Such water shall be injected under pressure as described in subparagraph, Truck Mixers. Every load of concrete delivered to the paving site shall be accompanied by a batch ticket from the operator of the batching plant. Tickets shall be on approved forms and shall show at least the mass, or volume, of all ingredients in each batch delivered, and the time of day. Tickets shall be delivered to the placing foreman who shall keep them on file and deliver them to the Government weekly.

3.4.1 Batching and Mixing Concrete

The batching and mixing equipment and the operation thereof shall conform to the requirements of paragraph EQUIPMENT and as specified herein. All equipment shall be kept clean and in operable condition at all times. Scale pivots and bearings shall be kept clean and free of rust. Any equipment which fails to perform as specified shall immediately be removed from use until properly repaired and adjusted, or replaced.

3.4.2 Transporting and Transfer - Spreading Operations

The transporting and transfer equipment and the operation thereof shall conform to the requirements of paragraph EQUIPMENT and as specified herein. All equipment shall be kept clean and in operable condition at all times. Non-agitating equipment shall be used only on smooth roads and for haul time less than 15 the prepared and compacted underlying material in front of the paver-finisher. Equipment shall be allowed to operate on the underlying material only if approved in writing and only if no damage is done to the underlying material and its degree of compaction. Any disturbance to the underlying material that does occur shall be corrected, as approved, before the paver-finisher or the deposited concrete reaches the location of the disturbance and the equipment shall be replaced or procedures changed to prevent any future damage. Concrete shall be deposited as close as possible to its final position in the paving lane. All equipment shall be operated to discharge and transfer concrete without segregation. In no case shall dumping of concrete in discrete piles be permitted. No transfer or spreading operation which requires the use of front-end loaders, dozers, or similar equipment to distribute the concrete will be permitted. All batching and mixing, transporting, transferring, paving, and finishing shall be properly coordinated and controlled such that the paver-finisher has a continuous forward movement at a reasonably uniform speed from beginning to end of each paving lane, except for inadvertent equipment breakdown. Failure to achieve this shall require the Contractor to halt operations, regroup, and modify operations to achieve this requirement.

3.5 PAVING

3.5.1 General Requirements

The paving and finishing equipment and the operation thereof shall conform to the requirements of paragraph EQUIPMENT and as specified herein. All equipment shall be kept clean and properly operable at all times. Pavement shall be constructed with paving and finishing equipment utilizing rigid fixed forms or by use of slipform paving equipment. Paving and finishing equipment and procedures shall be capable of constructing paving lanes of the required width at a rate of at least 30 m of paving lane per hour on a routine basis. Paving equipment and its operation shall be controlled, and coordinated with all other operations, such that the paver-finisher has a continuous forward movement, at a reasonably uniform speed, from beginning to end of each paving lane, except for inadvertent equipment breakdown. Workmen with foreign material on their footwear or construction equipment that might deposit foreign material shall not be permitted to walk or operate in the plastic concrete.

3.5.2 Consolidation

Concrete shall be consolidated with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. Gang-mounted vibrator spuds shall be spaced so as to thoroughly consolidate the entire paving lane, but not more than 750 mm spacing, and with the outside vibrators not more than 300 mm from the edge of the lane. The vibrators shall be inserted into the concrete to a depth that will provide the best full-depth consolidation but not closer to the underlying material than 50 mm. The vibrators or any tamping units in front of the paver shall be automatically controlled so that they shall be stopped immediately as forward motion ceases. Excessive vibration shall not be permitted. If the vibrators cause visible tracking in the paving lane, the paving operation shall be stopped and equipment and operations modified to prevent it. Concrete in small, odd-shaped slabs or in isolated locations inaccessible to the gang-mounted vibration equipment shall be vibrated with an approved hand-operated immersion vibrator. Vibrators shall not be used to transport or spread the concrete. Hand-operated vibrators shall not be operated in the concrete at one location for more than 20 seconds. For each paving train, at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators shall be maintained at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) shall require the immediate stopping of the paving operation and approved adjustment of the equipment or procedures.

3.5.3 Operation

When the paver approaches a header at the end of a paving lane, a sufficient amount of concrete shall be maintained ahead of the paver to provide a roll of concrete which will spill over the header. The amount of extra concrete shall be sufficient to prevent any slurry that is formed and carried along ahead of the paver from being deposited adjacent to the header. The spud vibrators in front of the paver shall be brought as close to the header as possible before they are lifted. Additional consolidation shall be provided adjacent to the headers by hand-manipulated vibrators. When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), provisions shall be made to prevent damage to the previously constructed pavement. Transversely oscillating screeds and extrusion plates shall overlap the existing pavement the minimum possible, but in no case more than 200 mm. These screeds or extrusion plates shall be electronically controlled from the previously placed pavement so as to

prevent them from applying pressure to the existing pavement and to prevent abrasion of the pavement surface. The overlapping area of existing pavement surface shall at all times be kept completely free of any loose or bonded foreign material as the paver-finisher operates across it. When the paver travels on existing pavement, approved provisions shall be made to prevent damage to the existing pavement. Pavers using transversely oscillating screeds shall not be used to form fill-in lanes that have widths less than a full width for which the paver was designed or adjusted.

3.5.4 Required Results

The paver-finisher, and its gang-mounted vibrators, together with its operating procedures shall be adjusted and operated and coordinated with the concrete mixture being used to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. The screed or the extrusion plate shall be properly adjusted to produce a pavement surface true to line and grade. Any necessary adjustment to compensate for surging behind the screed or for inadequate height of surface after paving shall be carefully made and checked frequently. The paver-finishing operation shall produce a surface finish free of irregularities, tears, voids of any kind, and any other discontinuities. It shall produce only a very minimum of paste at the surface; never more than 2.5 mm cover over the top layer of coarse aggregate. The paver-finisher shall make only one pass across the pavement; multiple passes will not be permitted. The equipment and its operation shall produce a finished surface requiring no hand finishing other than the use of cutting straightedges, except in very infrequent instances. If any equipment or operation fails to produce the above results, the paving shall be stopped, the equipment shall be replaced or properly adjusted, the operation shall be appropriately modified, or the mixture proportions modified, in order to produce the required results before recommencing paving. No water, other than true fog sprays (mist) as specified in paragraph, Prevention of Plastic Shrinkage Cracking, shall be applied to the concrete or the concrete surface during paving and finishing.

3.5.5 Fixed Form Paving

Paving equipment for fixed-form paving and the operation thereof shall conform to the requirements of paragraph EQUIPMENT, all requirements specified above under paragraph PAVING and as specified herein.

3.5.5.1 Forms for Fixed-Form Paving

a. Forms shall be steel, except that wood forms may be used for curves having a radius of 45 m or less, and for fillets. Forms shall be equal in depth to the edge thickness of the slab as shown on the drawings. Forms shall be in one piece for the full depth required, except as permitted below. Under no conditions shall forms be adjusted by filling or excavating under the forms to an elevation other than the bottom of the pavement slab. Where the project requires several different slab thicknesses, forms may be built up with metal or wood to provide an increase in depth of not more than 25 percent. The required form depth may be obtained by securely bolting or welding to the bottom of the form a tubular metal section of the proper thickness or by securely bolting wood planks to the bottom of the form. The tubular metal section or wood planks shall completely cover the underside of the base of the form and shall extend beyond the edge of the base a sufficient distance to provide the necessary stability. The base width of

the one-piece form, or built-up form, shall be not less than eight-tenths of the vertical height of the form, except that forms 200 mm or less in vertical height shall have a base width not less than the vertical height of the form. Forms shall not be built-up by adding to the top. The top surface of each form section shall not vary more than 1.5 mm in 4 m from a true line. The face of the form shall not vary more than 5 mm in 4 m from a true plane. Forms with battered top surfaces or distorted faces or bases shall be removed from the project. Where keyway forms are required, they shall be rigidly attached to the main form so no displacement can take place. Metal keyway forms shall be tack-welded to steel forms. Keyway forms shall be so aligned that there is no variation over 6 mm either vertically or horizontally, when tested with a 4 m template after forms are set, including tests across form joints.

b. Steel forms shall be furnished in sections not less than 3 m in length, except that on curves having a radius of 45 m or less, the length of the sections shall be 1.5 m unless the sections are flexible or curved to the proper radius. Each 3 m length of form shall be provided with at least three form braces and pin sockets so spaced that the form will be rigidly braced throughout its length. Lock joints between form sections shall be free from play or movement. Forms shall be free of warps, bends, or kinks.

c. Wood forms for curves and fillets shall be made of well-seasoned, surfaced plank or plywood, straight, and free from warp or bend. Wood forms shall be adequate in strength and rigidly braced.

d. The forms shall be set on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire length and base width. Underlying material shall be thoroughly compacted and trimmed to grade before forms are set in place. Setting forms on blocks or on built-up spots of underlying material will be not permitted under any condition. The form sections shall be staked into position and tightly locked together. The length of pins and quantity provided in each section shall be sufficient to hold the form at the correct line and grade. When tested with a straightedge, the top of the installed form shall conform to the requirements specified for the finished surface of the concrete, and the longitudinal axis of the upstanding leg shall not vary more than 6 mm from the straightedge. Conformity to the alignment and grade elevations shown on the drawings shall be checked and necessary corrections shall be made immediately prior to placing the concrete. Forms shall be set well in advance of concrete placement. The forms shall be cleaned and oiled each time before concrete is placed. No concrete shall be placed until setting of forms has been checked and approved by the CQC team.

3.5.5.2 Form Removal

Forms shall remain in place at least 12 hours after the concrete has been placed. When conditions are such that the early strength gain of the concrete is delayed, the forms shall be left in place for a longer time, as directed. Forms shall be removed by procedures that do not injure the concrete. Bars or heavy metal tools shall not be used directly against the

concrete in removing the forms. Any concrete found to be defective after form removal shall be repaired promptly, using procedures specified hereinafter or as directed.

3.5.6 Slipform Paving

3.5.6.1 General

Paving equipment for slipform paving and the operation thereof shall conform to the requirement of paragraph EQUIPMENT, all requirements specified above in subparagraphs, General, Consolidation, Operation, and Required Results, and as specified herein. The slipform paver shall shape the concrete to the specified and indicated cross section, meeting all tolerances, in one pass. The slipform paver shall finish the surface and edges so that only a very minimum isolated amount of hand finishing is required. If the paving operation does not meet the above requirements and the specified tolerances, the operation shall be immediately stopped, and the Contractor shall regroup and replace or modify any equipment as necessary, modify paving procedures or modify the concrete mix, in order to resolve the problem. The slipform paver shall be automatically electronically controlled from a taut wire guideline for horizontal alignment and on both sides from a taut wire guideline for vertical alignment, except that electronic control from a ski operating on a previously constructed adjoining lane shall be used where applicable for either or both sides. Automatic, electronic controls for vertical alignment shall always be used on both sides of the lane. Control from a slope-adjustment control or control operating from the underlying material shall never be used. If approved by the Contracting Officer after a preconstruction demonstration, automatic laser controls may be used in lieu of or to supplement the taut wire guidelines. Side forms on slipform pavers shall be properly adjusted so that the finished edge of the paving lane meets all specified tolerances. Dowels in longitudinal construction joints shall be installed as specified below. The installation of these dowels by dowel inserters attached to the paver or by any other means of inserting the dowels into the plastic concrete shall not be permitted. If a keyway is required, a 0.45 to 0.55 mm thick metal keyway liner shall be installed as the keyway is extruded. The keyway liner shall be protected and shall remain in place and become part of the joint.

3.5.6.2 Guideline for Slipform Paving

Guidelines shall be accurately and securely installed well in advance of concrete placement. Supports shall be provided at necessary intervals to eliminate all sag in the guideline when properly tightened. The guideline shall be high strength wire set with sufficient tension to remove all sag between supports. Supports shall be securely staked to the underlying material or other provisions made to ensure that the supports will not be displaced when the guideline is tightened or when the guideline or supports are accidentally touched by workmen or equipment during construction. The appliances for attaching the guideline to the supports shall be capable of easy adjustment in both the horizontal and vertical directions. When it is necessary to leave gaps in the guideline to permit equipment to use or cross underlying material, provisions shall be made for quickly and accurately replacing the guideline without any delay to the forward progress of the paver. Supports on either side of the gap shall be secured in such a manner as to avoid disturbing the remainder of the guideline when the portion across the gap is positioned and tightened. The guideline across the gap and adjacent to the gap for a distance of 60 m shall be

checked for horizontal and vertical alignment after the guideline across the gap is tightened. Vertical and horizontal positioning of the guideline shall be such that the finished pavement shall conform to the alignment and grade elevations shown on the drawings within the specified tolerances for grade and smoothness. The specified tolerances are intended to cover only the normal deviations in the finished pavement that may occur under good supervision and do not apply to setting of the guideline. The guideline shall be set true to line and grade.

3.5.6.3 Laser Controls

If the Contractor proposes to use any type of automatic laser controls, a detailed description of the system shall be submitted and a trial field demonstration shall be performed in the presence of the Contracting Officer at least one week prior to start of paving. Approval of the control system will be based on the results of the demonstration and on continuing satisfactory operation during paving.

3.5.7 Placing Reinforcing Steel

The type and amount of steel reinforcement shall be as shown on the drawings. For pavement thickness of 300 mm or more, the reinforcement steel shall be installed by the strike-off method wherein a layer of concrete is deposited on the underlying material, consolidated, and struck to the indicated elevation of the steel reinforcement. The reinforcement shall be laid upon the prestruck surface, and the remaining concrete shall then be placed and finished in the required manner. When placement of the second lift causes the steel to be displaced horizontally from its original position, provisions shall be made for increasing the thickness of the first lift and depressing the reinforcement into the unhardened concrete to the required elevation. The increase in thickness shall be only as necessary to permit correct horizontal alignment to be maintained. Any portions of the bottom layer of concrete that have been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with newly mixed concrete without additional cost to the Government. For pavements less than 300 mm thick, the reinforcement shall be positioned on suitable chairs securely fastened to the subgrade prior to concrete placement. Concrete shall be vibrated after the steel has been placed. Regardless of placement procedure, the reinforcing steel shall be free from coatings which could impair bond between the steel and concrete, and laps in the reinforcement shall be as indicated. In lieu of the above, automatic reinforcement depressing attachments may be used to position the reinforcement, either bar mats or welded wire fabric, provided the entire operation is approved by the Contracting Officer. Regardless of the equipment or procedures used for installing reinforcement, the Contractor shall ensure that the entire depth of concrete is adequately consolidated.

3.5.8 Placing Dowels and Tie Bars

The method used in installing and holding dowels in position shall ensure that the error in alignment of any dowel from its required alignment after the pavement has been completed will not be greater than 1 mm per 100 mm Except as otherwise specified below, location of dowels shall be within a horizontal tolerance of plus or minus 15 mm. The Contractor shall furnish an approved template for checking the alignment and position of the dowels. The portion of each dowel intended to move within the concrete or expansion cap shall be painted with one coat of the specified paint. When dry, the painted portion shall be wiped clean and coated with a thin, even

film of lubricating oil before the concrete is placed. Pipe used as dowels shall be filled with a stiff sand-asphalt mixture or portland-cement mortar. Dowels and tie bars in joints shall be omitted when the center of the dowel or tie bar is located within a horizontal distance from an intersecting joint equal to or less than one-fourth of the slab thickness. Dowels shall be installed as specified in the following subparagraphs.

3.5.8.1 Contraction Joints

Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place, as indicated, by means of rigid metal frames or basket assemblies of an approved type. The assemblies shall consist of a framework of metal bars or wires arranged to provide rigid support for the dowels and the tie bars throughout the paving operation, with a minimum of four continuous bars or wires extending along the joint line. The dowels and tie bars shall be welded to the assembly or held firmly by mechanical locking arrangements that will prevent them from rising, sliding out, or becoming distorted during paving operations. The basket assemblies shall be held securely in the proper location by means of suitable pins or anchors. At the Contractor's option, in lieu of the above, dowels and tie bars in contraction joints shall be installed near the front of the paver by insertion into the plastic concrete using approved equipment and procedures. Approval will be based on the results of a preconstruction demonstration which the Contractor shall conduct, showing that the dowels and tie bars are installed within specified tolerances.

3.5.8.2 Construction Joints-Fixed Form Paving

Installation of dowels and tie bars shall be by the bonded-in-place method. Installation by removing and replacing in preformed holes will not be permitted. Dowels and tie bars shall be prepared and placed across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms. If split dowels are approved and used, the female portion of the split dowel shall be bonded in the initially placed pavement lane. The female portion of the split dowel shall be securely fastened to the pavement form and shall maintain the proper position and alignment of the dowel during concrete placement so that no mortar or other foreign material will enter the socket or coupling. Before the split dowels are assembled, the external and internal threads shall be cleaned thoroughly to remove all cement, cement mortar, grit, dirt, and other foreign matter. In the final assembly, a minimum torque of 270 N-m shall be applied. The spacing of dowels and tie bars in construction joints shall be as indicated, except that, where the planned spacing cannot be maintained because of form length or interference with form braces, closer spacing with additional dowels or tie bars shall be used.

3.5.8.3 Dowels Installed in Hardened Concrete

Dowels installed in hardened concrete, such as in longitudinal construction joints for slipform paving, in joints between new and existing pavement, and similar locations, shall be installed by bonding the dowels into holes drilled into the hardened concrete. The installation of dowels in longitudinal construction joints by dowel inserters attached to a slipform paver or by any other means of inserting the dowels into the plastic concrete shall not be permitted. Holes approximately 3 mm greater in

diameter than the dowels shall be drilled into the hardened concrete with rotary core drills to receive the dowels. In lieu of rotary drills, the contractor may use percussion drills, provided that spalling at the collar of the hole does not occur. Regardless of the type of drill used, the drill shall be held rigidly in exact alignment by means of a stable jig or framework, solidly supported; gang drills meeting this are acceptable. Any damage to the concrete face during drilling shall be repaired as directed; continuing damage shall require modification of the equipment and operation. Dowels shall be bonded in the drilled holes using epoxy resin. Epoxy resin shall be injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel shall not be permitted. The dowels shall be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic collar fitted around the dowel. The vertical alignment of the dowels shall be checked by placing a straightedge on the surface of the pavement over the top of the dowel and measuring the vertical distance between the straightedge and the beginning and ending point of the exposed part of the dowel. The horizontal alignment shall be checked with a framing square. Dowels required to be installed in any joints between new and existing concrete shall be grouted in holes drilled in the existing concrete, all as specified above. Where tie bars are required in longitudinal construction joints of slipform pavement, bent tie bars shall be installed at the paver, in front of the transverse screed or extrusion plate. If tie bars are required, a standard keyway shall be constructed, and the bent tie bars shall be inserted into the plastic concrete through a 0.45 to 0.55 mm thick metal keyway liner. Tie bars shall not be installed in preformed holes. The keyway liner shall be protected and shall remain in place and become part of the joint. When bending tie bars, the radius of bend shall not be less than the minimum recommended for the particular grade of steel in the appropriate material standard. Before placement of the adjoining paving lane, the tie bars shall be straightened, using procedures which will not spall the concrete around the bar.

3.5.8.4 Expansion Joints

Dowels in expansion joints shall be installed as shown using appropriate procedures specified above.

3.5.9 INTEGRAL OR MONOLITHIC CURBS

Monolithic curbs shall be constructed to dimensions and at locations indicated. Curbs shall be constructed of portland cement conrete conforming with these specifications except as modified herein. Forms for curbs shall be of similar material to that used for pavement. The outside form shall be of a depth equal to the combined depth of integral curb and pavement slab. The form may be a built-up section, the lower portion equal to the depth of the pavement slab and the upper portion equal to the depth of the integral curb. The built-up form shall be so designed as to assure rigid connection between lower and upper portions. The inside curb form shall be securely fastened to and supported by the outside form. Fastenings shall be designed so as not to obstruct satisfactory finishing and edging of top of curb and to permit early removal of the face of the form. Inside curb forms will not be required when approved procedures such as use of a "mule" or other finishing equipment is used to finish the surface of the plastic concrete to the required shape. The concrete curb shall be placed at the same time or as soon as practical after slab is

placed, but in no case shall the time between the placing of the slab and placing of curb exceed 45 minutes. Concrete shall be thoroughly spaded or vibrated until well compacted and until a good bond is obtained between curb and slab. Transverse joints shall be the type and construction specified for transverse joints for the pavement slab on which curb is placed. Pavement joints shall extend through the curb except that horizontal dowels will not be required between joints in the curb. Top of curb shall be floated in such a manner as to compact the concrete thoroughly and produce a smooth even surface. Edges of curb and joints shall be rounded by using appropriate edging tools. Vertical edges of joints shall be dressed when the curb form is removed. While the concrete is green, the top and face of the curb shall be finished by rubbing the surface with a wood or concrete rubbing block and water until all blemishes, form marks, and tool marks are removed. Ample water shall be used during the rubbing to avoid plastered condition. The rubbed surface shall then be brushed with a a fine-textured brush to obtain a uniform surface texture. The face of the finished curb shall vary not more than 3 mm from the edge of a 3 m straightedge, except at grade changes or curves. Visible surfaces and edges of the finished curb shall befree of blemishes, form and tool marks, and shall be uniform in color, shape, and appearance.

3.6 FINISHING

The finishing machine, or paver-finisher, shall meet all requirements specified in paragraph EQUIPMENT and herein. Finishing operations shall be a continuing part of placing operations starting immediately behind the strike-off of the paver and the machines shall be designed and operated to strike off, screed, and consolidate the concrete. Initial finishing shall be provided by the transverse screed or extrusion plate. The sequence of operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Finishing shall be by the machine method. The hand method shall be used only infrequently and only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. When approved, the hand finishing method may also be used for separate, isolated slabs during removal and replacement type repair operations. Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Equipment to be used for supplemental hand finishing shall primarily be 3 to 4 m cutting straightedges; only very sparing use of bull floats shall be allowed. Any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing, shall be immediately stopped and proper adjustments made or the equipment replaced. Every effort shall be made to prevent bringing excess paste to the surface and any operations which produce more than 2.5 mm of paste (mortar, water, laitance, etc.) over the top layer of coarse aggregate shall be halted immediately and the equipment, mixture, or procedures modified as necessary. Compensation shall be made for surging behind the screeds or extrusion plate and settlement during hardening and care shall be taken to ensure that paving and finishing machines are properly adjusted so that the finished surface of the concrete (not just the cutting edges of the screeds) will be at the required line and grade. Surface checks shall be made regularly and paving operations immediately halted and adjustments made whenever compensation is inadequate. Screed and float adjustments of the machines shall be checked at the start of each day's paving operations and more often if required. Machines that cause frequent delays due to mechanical failure shall be replaced. When machines ride the edge of a previously constructed slab, the edge shall be kept clean and provision shall be made to protect the surface of the slab.

Clary screeds, "bridge deck" finishers, or other rotating pipe or tube type equipment will not be permitted. Finishing equipment and tools shall be maintained clean and in an approved condition. At no time shall water be added to the surface of the slab with the finishing equipment or tools, or in any other way, except for fog (mist) sprays specified to prevent plastic shrinkage cracking.

3.6.1 Longitudinal Floating

When the equipment contains a mechanical, longitudinal, oscillating float, the float shall be operated to smooth and finish the pavement immediately behind the transverse screed or extrusion plate. The float shall be operated maintaining contact with the surface at all times. Care shall be taken to prevent working paste to the surface in excess of the amount specified above.

3.6.2 Other Types of Finishing Equipment

Concrete finishing equipment of types other than those specified above may be used on a trial basis, when specifically approved, except that rotating pipe or tubes or bridge deck finishers will not be permitted. Approval will be given after demonstration on a test section prior to start of construction, and provided the Contracting Officer determines that the pavement produced is better than that produced by the specified equipment. The use of equipment that fails to produce finished concrete of the required quality, using concrete proportions and slump as specified, shall be discontinued, and the concrete shall be finished with specified equipment and in the manner specified above. Vibrating screeds or pans shall be used only for isolated slabs where hand finishing is permitted as specified, and only where specifically approved. Slipform paving equipment shall not be operated on fixed forms unless approved in writing prior to use.

3.6.3 Machine Finishing With Fixed Forms

The machine shall be designed to ride the forms and shall be operated to screed and consolidate the concrete. Machines that cause displacement of the forms shall be replaced. The machine shall make only one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

3.6.4 Machine Finishing With Slipform Pavers

The slipform paver shall be operated so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Any equipment or procedure that fails to meet these specified requirements shall immediately be replaced or modified as necessary. A self-propelled nonrotating pipe float may be used if the Contractor desires while the concrete is still plastic, to remove minor irregularities and score marks. The pipe float shall be 150 to 250 mm in diameter and sufficiently long to span the full paving width when oriented at an angle of approximately 60 degrees with the center line. Only one pass of the pipe float shall be allowed. If there is sufficient concrete slurry or fluid paste on the surface that it runs over the edge of the pavement, the paving operation shall be immediately stopped and the equipment, mixture, or operation modified to prevent formation of such

slurry. Any slurry which does run down the vertical edges shall be immediately removed by hand, using stiff brushes or scrapers. No slurry, concrete or concrete mortar shall be used to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens. Slabs having areas of edge slump in excess of the specified tolerances shall be removed and replaced in accordance with paragraph, REPAIR, REMOVAL, REPLACEMENT OF SLABS; repair operations on such areas will not be permitted.

3.6.5 Surface Correction and Testing

After all other finishing is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of cutting straightedges. Such straightedges shall be 4 m in length and shall be operated from the sides of the pavement and from bridges. A straightedge operated from the side of the pavement shall be equipped with a handle 1 m longer than one-half the width of the pavement. The surface shall then be tested for trueness with a straightedge held in successive positions parallel and at right angles to the center line of the pavement, and the whole area covered as necessary to detect variations. The straightedge shall be advanced along the pavement in successive stages of not more than one-half the length of the straightedge. Depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. Projections above the required elevation shall also be struck off and refinished. The straightedge testing and finishing shall continue until the entire surface of the concrete is free from observable departure from the straightedge and conforms to the surface requirements specified in paragraph ACCEPTABILITY OF WORK AND PAYMENT ADJUSTMENTS. Long-handled, flat bull floats shall be used very sparingly and only as necessary to correct minor, scattered surface defects. If frequent use of bull floats is necessary, the paving operation shall be stopped and the equipment, mixture or procedures adjusted to eliminate the surface defects. Finishing with hand floats and trowels shall be held to the absolute minimum necessary. Extreme care shall be taken to prevent overfinishing joints and edges. The surface finish of the pavement shall be produced essentially by the finishing machine and not by subsequent hand finishing operations. All hand finishing operations shall be subject to approval and shall be modified when directed. No water shall be added to the pavement surface during these operations.

3.6.6 Hand Finishing

Hand finishing operations shall be used only as specified above.

3.6.6.1 Equipment

In addition to approved mechanical internal vibrators for consolidating the concrete, a strike-off and tamping template and a longitudinal float shall be provided for hand finishing. The template shall be at least 300 mm longer than the width of pavement being finished, of an approved design, and sufficiently rigid to retain its shape, and shall be constructed of metal or other suitable material shod with metal. The longitudinal float shall be at least 3 m long, of approved design, and rigid and substantially braced, and shall maintain a plane surface on the bottom . Grate tampers (jitterbugs) shall not be used.

3.6.6.2 Finishing and Floating

As soon as placed and vibrated, the concrete shall be struck off and screeded to the crown and cross section and to such elevation above grade that when consolidated and finished, the surface of the pavement will be at the required elevation. The entire surface shall be tamped with the strike-off and tamping template, and the tamping operation continued until the required compaction and reduction of internal and surface voids are accomplished. Immediately following the final tamping of the surface, the pavement shall be floated longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, additional concrete shall be placed and screeded, and the float operated until a satisfactory surface has been produced. The floating operation shall be advanced not more than half the length of the float and then continued over the new and previously floated surfaces. Long-handled, flat bull floats shall be used very sparingly and only as necessary to correct minor, scattered surface defects. If frequent use of bull floats is necessary, the operation shall be stopped and adjusted to eliminate the surface defects. Finishing with hand floats and trowels shall be held to the absolute minimum necessary. Extreme care shall be taken to prevent overfinishing joints and edges. No water shall be added to the pavement during finishing operations.

3.6.7 Texturing

Before the surface sheen has disappeared and before the concrete hardens, the surface of the pavement shall be given a texture as described herein. After curing is complete, all textured surfaces shall be thoroughly power broomed to remove all debris.

3.6.7.1 Burlap Drag Surface Finish

Surface texture shall be applied by dragging the surface of the pavement, in the direction of the concrete placement, with an approved fabric drag. The drag shall be operated with the fabric moist, and the fabric shall be cleaned or changed as required to keep clean. The dragging shall be done so as to produce a uniform finished surface having a fine sandy texture without disfiguring marks.

3.6.8 Edging

After texturing has been completed, the edge of the slabs along the forms, along the edges of slipformed lanes, and at the joints shall be carefully finished with an edging tool to form a smooth rounded surface of 3 mm radius. Tool marks shall be eliminated, and the edges shall be smooth and true to line. No water shall be added to the surface during edging. Extreme care shall be taken to prevent overworking the concrete.

3.6.9 Outlets in Pavement

Recesses for the tie-down anchors, lighting fixtures, and other outlets in the pavement shall be constructed to conform to the details and dimensions shown. The concrete in these areas shall be carefully finished to provide a surface of the same texture as the surrounding area that will be within the requirements for plan grade and surface smoothness.

3.7 CURING

3.7.1 General

Concrete shall be continuously protected against loss of moisture and rapid temperature changes for at least 7 days from the completion of finishing operations. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Sufficient sheet material to protect unhardened concrete from rain shall be at the paver at all times. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period. If any selected method of curing does not afford the proper curing and protection against concrete cracking, the damaged pavement shall be removed and replaced, and another method of curing shall be employed as directed. Curing shall be accomplished by one of the following methods .

3.7.2 Membrane Curing

A uniform coating of white-pigmented, membrane-forming, curing compound shall be applied to the entire exposed surface of the concrete as soon as the free water has disappeared from the surface after finishing. If evaporation is high and no moisture is present on the surface even though bleeding has not stopped, fog sprays shall be used to keep the surface moist until setting of the cement occurs and bleeding is complete. Curing compound shall then be immediately applied. Along the formed edge faces, it shall be applied immediately after the forms are removed. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water, and the curing compound applied as soon as the free water disappears. The curing compound shall be applied to the finished surfaces by means of an approved automatic spraying machine. The spraying machine shall be self-propelled and shall span the newly paved lane. The machine shall have one or more spraying nozzles that can be controlled and operated to completely and uniformly cover the pavement surface with the required amount of curing compound. The curing compound in the drum used for the spraying operation shall be thoroughly and continuously agitated mechanically throughout the full depth of the drum during the application. Air agitation may be used only to supplement mechanical agitation. Spraying pressure shall be sufficient to produce a fine spray as necessary to cover the surface thoroughly and completely with a uniform film. Spray equipment shall be kept clean and properly maintained and the spray nozzle or nozzles shall have adequate wind shields. The curing compound shall be applied with an overlapping coverage that will give a two-coat application at a coverage of 10 square meters per L , plus or minus 5.0 percent for each coat. A one-coat application may be applied provided a uniform application and coverage of 5 square meters per L., plus or minus 5.0 percent is obtained. The application of curing compound by hand-operated, mechanical powered pressure sprayers will be permitted only on odd widths or shapes of slabs where indicated and on concrete surfaces exposed by the removal of forms. When the application is made by hand-operated sprayers, the second coat shall be applied in a direction approximately at right angles to the direction of the first coat. The compound shall form a uniform, continuous, cohesive film that will not check, crack, or peel and that will be free from pinholes and other discontinuities. If pinholes, abrasions, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent

construction operations within the curing period shall be immediately resprayed. The surfaces adjacent to joint sawcuts shall be cleaned and resprayed with curing compound immediately after cutting. Approved standby facilities for curing concrete pavement shall be provided at an accessible location at the job site for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.8 JOINTS

3.8.1 General

Joints shall conform to the details indicated and shall be perpendicular to the finished grade of the pavement. All joints shall be straight and continuous from edge to edge or end to end of the pavement with no abrupt offset and no gradual deviation greater than 12 mm. Before commencing construction, the Contractor shall submit for approval a control plan and equipment to be used for ensuring that all joints are straight from edge to edge of the pavement within the above tolerances. Where any joint fails to meet these tolerances, the slabs adjacent to the joint shall be removed and replaced at no additional cost to the Government. No change from the jointing pattern shown on the drawings shall be made without written approval of the Contracting Officer. Sealing of joints shall be in accordance with Section 02760 Field Molded Sealants.

3.8.2 Longitudinal Construction Joints

Longitudinal construction joints between paving lanes shall be located as indicated. Dowels or keys or tie bars shall be installed in the longitudinal construction joints, or the edges shall be thickened as indicated. Dowels Tie bars shall be installed in conformance with paragraph, Placing Dowels and Tie Bars. When the concrete is placed using stationary forms, metal keyway forms securely fastened to the concrete form shall be used to form a keyway in the plastic concrete. When the concrete is placed using slipform pavers, a keyway shall be formed in the plastic concrete by means of metal forms permanently attached to the side forms or by means of preformed metal keyway liners, which are inserted during the slipform operations and may be left in place. The dimensions of the keyway forms shall not vary more than plus or minus 3 mm from the dimensions indicated and shall not deviate more than plus or minus 6 mm from the mid-depth of the pavement. There shall be no abrupt offset either horizontally or vertically in the completed keyway. If any length of completed keyway of 1.5 m or more fails to meet the above tolerances, dowels shall be installed in that part of the joint by drilling holes in the hardened concrete and grouting the dowels in place with epoxy resins using approved materials and procedures. After the end of the curing period, longitudinal construction joints shall be sawed to provide a groove at the top for sealant conforming to the details and dimensions indicated.

3.8.3 Transverse Construction Joints

Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when

concrete placement is interrupted for 30 minutes or longer. When concrete placement cannot be continued, the transverse construction joint shall be installed at a planned transverse joint, if possible. Transverse construction joints shall be constructed by utilizing headers and the very minimum amount of hand placement and finishing techniques. Pavement shall be constructed with the paver as close to the header as possible, and the paver shall be run out completely past the header. Transverse construction joints installed at a planned transverse joint shall be constructed as shown or, if not shown otherwise, shall be dowelled. Those not at a planned transverse joint shall be constructed with tie bars and shall not be sawed or sealed.

3.8.4 Expansion Joints

Expansion joints shall be formed where indicated, and about any structures and features that project through or into the pavement, using joint filler of the type, thickness, and width indicated, and shall be installed to form a complete, uniform separation between the structure and the pavement. The filler shall be attached to the original concrete placement with adhesive or other fasteners and shall extend the full slab depth. Adjacent sections of filler shall be fitted tightly together, and the filler shall extend across the full width of the paving lane or other complete distance in order to prevent entrance of concrete into the expansion space. Edges of the concrete at the joint face shall be finished with an edger with a radius of 3 mm. The joint filler strips shall be installed 20 mm below the pavement surface with a slightly tapered, dressed-and-oiled wood strip or other approved material temporarily secured to the top of the filler to form a recess to be filled with joint sealant. The wood strip shall be removed soon after the concrete has set and the reservoir temporarily filled with an approved material to protect the reservoir until the joint sealer is installed. Expansion joints shall be constructed with dowels or thickened edges for load transfer, as indicated.

3.8.5 Contraction Joints

Transverse and longitudinal contraction joints shall be of the weakened-plane or dummy type and shall be constructed as indicated. Longitudinal contraction joints shall be constructed by sawing a groove in the hardened concrete with a power-driven saw in conformance with requirements for sawed joints, unless otherwise approved in writing. Transverse contraction joints shall be constructed in conformance with requirements for sawed joints.

3.8.5.1 Sawed Joints

Sawed contraction joints shall be constructed by sawing an initial groove in the concrete with a 3 mm blade to the indicated depth. During sawing of joints, and again 24 hours later, the CQC team shall inspect all exposed lane edges for development of cracks below the saw cut, and shall immediately report results to the Contracting Officer. If the Contracting Officer determines that there are more uncracked joints than desired, the Contractor will be directed to saw succeeding joints 25 percent deeper than originally indicated at no additional cost to the Government. After expiration of the curing period, the upper portion of the groove shall be widened by sawing to the width and depth indicated for the joint sealer. The time of initial sawing shall vary depending on existing and anticipated weather conditions and shall be such as to prevent uncontrolled cracking of the pavement. Sawing of the joints shall commence as soon as the concrete

has hardened sufficiently to permit cutting the concrete without chipping, spalling, or tearing. The sawed faces of joints will be inspected for undercutting or washing of the concrete due to the early sawing, and sawing shall be delayed if undercutting is sufficiently deep to cause structural weakness or excessive roughness in the joint. The sawing operation shall be carried on as required during both day and night regardless of weather conditions. The joints shall be sawed at the required spacing consecutively in the sequence of the concrete placement. A chalk line or other suitable guide shall be used to mark the alinement of the joint. Before sawing a joint, the concrete shall be examined closely for cracks, and the joint shall not be sawed if a crack has occurred near the planned joint location. Sawing shall be discontinued when a crack develops ahead of the saw cut. Workmen and inspectors shall wear clean, rubber-soled footwear, and the number of persons walking on the pavement shall be limited to those actually performing the sawing operation. Immediately after the joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly flushed with water until all waste from sawing is removed from the joint. The surface shall be resprayed with curing compound as soon as free water disappears. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, but that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed with cord, backer rod, or other approved material before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period and shall prevent infiltration of foreign material until removed immediately before sawing joint sealant reservoir. The sawing equipment shall be adequate in the number of units and the power to complete the sawing at the required rate. An ample supply of saw blades shall be available on the job before concrete placement is started and at all times during sawing. At least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operation.

3.8.6 Thickened Edge Joints

Thickened edge joints shall be constructed as indicated on the drawings. Underlying material in the transition area shall be graded as shown and shall meet the requirements for smoothness and compaction specified for all other areas of the underlying material.

3.8.7 Sealing Joints

Joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. Joints shall be sealed as specified in Section 02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS.

3.9 REPAIR, REMOVAL, REPLACEMENT OF SLABS

3.9.1 General

New pavement slabs that are broken or contain cracks shall be removed and replaced or repaired, as specified hereinafter at no cost to the Government. Spalls along joints shall be repaired as specified. Where removal of partial slabs is permitted, as specified, removal and replacement shall be full depth, shall be full width of the paving lane, and the limit of removal shall be normal to the paving lane and not less

than 3 m from each original transverse joint (i.e., removal portion shall be at least 3 m longitudinally, and portion to remain in place shall be at least 3 m 10 feet longitudinally; thus, if original slab length is less than 6 m, the entire slab shall be removed). The Contracting Officer will determine whether cracks extend full depth of the pavement and may require cores to be drilled on the crack to determine depth of cracking. Such cores shall be at least 150 mm diameter, shall be drilled by the Contractor and shall be filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with epoxy resin, using approved procedures. Drilling of cores and refilling holes shall be at no expense to the Government. All epoxy resin used in this work shall conform to paragraph EPOXY RESIN, Type and Grade as specified.

3.9.2 Slabs with Cracks Thru Interior Areas

Interior area is defined as that area more than 600 mm from either adjacent original transverse joint. Slabs with any cracks that extend into the interior area, regardless of direction, shall be treated by one of the following procedures.

3.9.2.1 Cracks That Do Not Extend Full Depth of Slab

These cracks, and similar cracks within the areas 600 mm each side of transverse joints, shall be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1, using procedures as approved. The procedure shall not widen the crack during epoxy resin injection. All epoxy resin injection shall take place in the presence of a representative of the Contracting Officer.

3.9.2.2 Cracks That Extend Full Depth of Slab

Where there is any full depth crack at any place within the interior area, the full slab shall be removed. However, if the cracked area all lies within 3 m of one original transverse joint, only a partial slab need be removed provided all criteria specified above for distance from each original transverse joint is met.

3.9.3 Cracks close to and Parallel to Transverse Joints

All cracks essentially parallel to original transverse joints, extending full depth of the slab, and lying wholly within 600 mm either side of the joint shall be treated as specified hereinafter. Any crack extending more than 600 mm from the transverse joint shall be treated as specified above for Slabs With Cracks Through Interior Areas. Any cracks which do not extend full depth of the slab shall be treated as specified above in subparagraph, Cracks That Do Not Extend Full Depth Of Slab, and the original transverse joint constructed as originally designed.

3.9.3.1 Full Depth Cracks Present, Original Joint Not Opened

When the original transverse joint has not opened, the crack shall be routed and sealed, and the original transverse joint filled with epoxy resin. The crack shall be routed with an easily guided, wheel mounted, vertical shaft, powered rotary router designed so the routing spindle will caster as it moves along the crack, or with a small diameter saw designed for this use. The reservoir for joint sealant in the crack shall be formed

by routing to a depth of 19 mm, plus or minus 1.5 mm, and to a width of 16 mm, plus or minus 3 mm. Any equipment or procedure which causes ravelling or spalling along the crack shall be modified or replaced to prevent such ravelling or spalling. The joint sealant shall be a liquid sealant as specified for rigid pavement joints. Installation of joint seal shall be as specified for sealing joints or as directed. The uncracked transverse joint shall be filled with epoxy resin. If the joint sealant reservoir has been sawed out, the reservoir and as much of the lower saw cut as possible shall be filled with epoxy resin, Type IV, Grade 2, thoroughly tooled into the void using approved procedures. If only the original narrow saw cut has been made, it shall be cleaned and pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. If filler material (joint insert) has been used to form a weakened plane in the transverse joint, it shall be completely sawed out and the saw cut pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. Where a parallel crack goes part way across the paving lane and then intersects and follows the original transverse joint which is cracked only for the remainder of the width, it shall be treated as follows: The area with the separate crack shall be treated as specified above for a parallel crack, and the cracked original joint shall be prepared and sealed as originally designed.

3.9.3.2 Full Depth Cracks, Original Joint Also Cracked

At a transverse joint, if there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap, a section of the slab containing the crack shall be removed and replaced for the full lane width and at least 3 m long. If this partial slab removal places the limit of removal less than 3 m from the next transverse joint, the entire slab shall be removed. If the parallel crack crosses the transverse joint line, a similar area shall be removed and replaced in both slabs.

3.9.4 Removal and Replacement of Full Slabs

Where it is necessary to remove full slabs, unless there are keys or dowels present, all edges of the slab shall be cut full depth with a concrete saw. All saw cuts shall be perpendicular to the slab surface. If keys, dowels, or tie bars are present along any edges, these edges shall be sawed full depth 150 mm from the edge if only keys are present, or just beyond the end of dowels or tie bars if they are present. These joints shall then be carefully sawed on the joint line to within 25 mm of the depth of the dowel or key. The main slab shall be further divided by sawing full depth, at appropriate locations, and each piece lifted out and removed. Suitable equipment shall be used to provide a truly vertical lift, and approved safe lifting devices used for attachment to the slabs. The narrow strips along keyed or doweled edges shall be carefully broken up and removed using light, hand-held jackhammers, 14 kg or less, or other approved similar equipment. Care shall be taken to prevent damage to the dowels, tie bars, or keys or to concrete to remain in place. The joint face below keys or dowels shall be suitably trimmed so that there is no abrupt offset in any direction greater than 12 mm and no gradual offset greater than 25 mm when tested in a horizontal direction with a straightedge. No mechanical impact breakers, other than the above hand-held equipment shall be used for any removal of slabs. If underbreak between 37 and 100 mm deep occurs at any point along any edge, the area shall be repaired as directed before replacing the removed slab. Procedures directed will be similar to those specified for surface spalls, modified as necessary. If underbreak over

100 mm deep occurs, the entire slab containing the underbreak shall be removed and replaced. Where there are no dowels, tie bars, or keys on an edge, or where they have been damaged, dowels of the size and spacing as specified for other joints in similar pavement shall be installed by epoxy grouting them into holes drilled into the existing concrete using procedures as specified in paragraph, Placing Dowels and Tie Bars. Original damaged dowels or tie bars shall be cut off flush with the joint face. Protruding portions of dowels shall be painted and lightly oiled. All four edges of the new slab shall thus contain dowels or original keys or original tie bars. Placement of concrete shall be as specified for original construction. Prior to placement of new concrete, the underlying material shall be recompacted and shaped as specified in the appropriate section of these specifications, and the surfaces of all four joint faces shall be cleaned of all loose material and contaminants and coated with a double application of membrane forming curing compound as bond breaker. Care shall be taken to prevent any curing compound from contacting dowels or tie bars. The resulting joints around the new slab shall be prepared and sealed as specified for original construction.

3.9.5 Removal and Replacement of Partial Slabs

Where the above criteria permits removal of partial slabs, removal and replacement operations shall be as specified for full slabs, except that the joint between the removed area and the partial slab to remain in place shall consist of a full depth saw cut across the full lane width and perpendicular to the centerline of the paving lane. Replacement operations shall be the same as specified above, except that, at the joint between the removed area and the partial slab to remain, deformed tie bars shall be epoxy resin grouted into holes drilled into the slab to remain in place. Size and spacing of the tie bars shall be as specified for dowels. Drilling of holes and installation of tie bars shall be as specified for dowels in paragraph, Placing Dowels and Tie Bars, except that no portion of the tie bars shall be painted or oiled. No curing compound shall be used on this joint face and, immediately before placing new concrete, the joint surface of the partial slab remaining in place shall be coated with epoxy resin, Type V, Grade 2.

3.9.6 Repairing Spalls Along Joints

Where directed, spalls along joints of new slabs, along edges of adjacent existing concrete, and along parallel cracks shall be repaired by first making a vertical saw cut at least 25 mm outside the spalled area and to a depth of at least 50 mm. Saw cuts shall be straight lines forming rectangular areas. The concrete between the saw cut and the joint, or crack, shall be chipped out to remove all unsound concrete and at least a depth of 12 mm of visually sound concrete. The cavity thus formed shall be thoroughly cleaned with high pressure water jets supplemented with compressed air to remove all loose material. Immediately before filling the cavity, a prime coat shall be applied to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff-bristle brush. Prime coat for portland cement repairs shall be a neat cement grout . The cavity shall be filled with low slump portland cement concrete . Portland cement concretes and mortars shall be very low slump mixtures, 12 mm slump or less, proportioned, mixed, placed, consolidated by tamping, and cured, all as directed. Mechanical vibrators and hand tampers shall be used to consolidate the concrete or mortar. Any repair material on the surrounding surfaces of the existing concrete shall

be removed before it hardens. Where the spalled area abuts a joint, an insert or other bond-breaking medium shall be used to prevent bond at the joint face. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir shall be thoroughly cleaned and then sealed with the sealer specified for the joints. If any spall penetrates half the depth of the slab or more, the entire slab, or 3 m portion thereof, shall be removed and replaced as previously specified. In lieu of sawing, spalls not adjacent to joints, and popouts, both less than 150 mm in maximum dimension, may be prepared by drilling a core 50 mm in diameter greater than the size of the defect, centered over the defect, and 50 mm deep or 12 mm into sound concrete, whichever is greater. The core hole shall be repaired as specified above for other spalls.

3.10 EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR

Existing concrete pavement shall be removed as indicated and as specified in Section 02220 DEMOLITION, modified, and expanded as specified herein. Repairs shall be made as indicated and as specified herein. All operations shall be carefully controlled to prevent damage to the concrete pavement and to the underlying material to remain in place. All saw cuts shall be made perpendicular to the slab surface, and forming rectangular areas.

3.10.1 Removal of Existing Pavement Slab

When existing concrete pavement is to be removed and adjacent concrete is to be left in place, the joint between the removal area and adjoining pavement to stay in place shall first be cut full depth with a standard diamond-type concrete saw. Next, a full depth saw cut shall be made parallel to the joint at least 600 mm from the joint and at least 150 mm from the end of any dowels. This saw cut shall be made with a wheel saw as specified in paragraph SAWING EQUIPMENT. All pavement to be removed beyond this last saw cut shall be removed using equipment and procedures specified in Section 02220 DEMOLITION and as approved. All pavement between this last saw cut and the joint line shall be removed by carefully pulling pieces and blocks away from the joint face with suitable equipment and then picking them up for removal. In lieu of this method, this strip of concrete may be carefully broken up and removed using hand-held jackhammers, 14 kg or less, or other approved light-duty equipment which will not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place. In lieu of the above specified removal method, the slab may be sawcut full depth to divide it into several pieces and each piece lifted out and removed. Suitable equipment shall be used to provide a truly vertical lift, and safe lifting devices used for attachment to the slab. Dowels of the size and spacing indicated shall be installed as shown on the drawings by epoxy resin bonding them in holes drilled in the joint face as specified in paragraph, Placing Dowels and Tie Bars.

3.10.2 Edge Repair

The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Areas which are damaged during construction shall be repaired at no cost to the Government; repair of previously existing damage areas will be considered a subsidiary part of concrete pavement construction.

3.10.2.1 Spall Repair

Spalls along joints and along cracks shall be repaired where indicated and where directed. Repair materials and procedures shall be as previously specified in subparagraph, Repairing Spalls Along Joints.

3.10.2.2 Underbreak Repair

All underbreak shall be repaired. First, all delaminated and loose material shall be carefully removed. Next, the underlying material shall be recompacted, without addition of any new material. Finally, the void shall be completely hand-filled with paving concrete mixture, thoroughly consolidated. Care shall be taken to produce an even joint face from top to bottom. Prior to placing concrete, the underlying material shall be thoroughly moistened. After placement, the exposed surface shall be heavily coated with curing compound.

3.10.2.3 Underlying Material

The underlying material adjacent to the edge of and under the existing pavement which is to remain in place shall be protected from damage or disturbance during removal operations and until placement of new concrete, and shall be shaped as shown on the drawings or as directed. Sufficient underling material shall be kept in place outside the joint line to completely prevent disturbance of material under the pavement which is to remain in place. Any material under the portion of the concrete pavement to remain in place which is disturbed or loses its compaction shall be carefully removed and replaced with concrete as specified above under Underbreak Repair. The underlying material outside the joint line shall be thoroughly compacted and shall be moist when new concrete is placed.

3.11 PAVEMENT PROTECTION

The Contractor shall protect the pavement against all damage prior to final acceptance of the work by the Government. Aggregates and similar construction materials shall not be piled on airfield pavements. Traffic shall be excluded from the new pavement by erecting and maintaining barricades and signs until the concrete is at least 14 days old, or for a longer period if so directed. As a construction expedient in paving intermediate lanes between newly paved pilot lanes, operation of the hauling equipment will be permitted on the new pavement after the pavement has been cured for 7 days and the joints have been sealed or otherwise protected. Also, the subgrade planer, concrete paving and finishing machines, and similar equipment may be permitted to ride upon the edges of previously constructed slabs when the concrete has attained a minimum flexural strength of 2.8 MPa and approved means are furnished to prevent damage to the slab edge. All new and existing pavement carrying construction traffic or equipment shall be continuously kept completely clean, and spillage of concrete or other materials shall be cleaned up immediately upon occurrence. Special care shall be used where Contractor's traffic uses or crosses active airfield pavement. In these areas, if necessary in order to accomplish this, full-time workmen with hand brooms shall be used at anytime there is traffic. Other existing pavements used by the Contractor shall be power broomed at least daily when traffic operates. For fill-in lanes, equipment shall be used that will not damage or spall the edges or joints of the previously constructed pavement.

3.12 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

3.12.1 General

The Contractor shall perform the inspection and tests described below, and based upon the results of these inspections and tests, shall take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the paving operation is out of control, concrete placement shall cease. The laboratory performing the tests shall be on-site and shall conform with ASTM C 1077. The individuals who sample and test concrete or the constituents of concrete as required in this specification shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I. The individuals who perform the inspection of concrete shall have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of Concrete Construction Inspector, Level II. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C 1077. This testing shall be performed by the Contractor regardless of any other testing performed by the Government, either for pay adjustment purposes or for any other reason.

3.12.2 Testing and Inspection Requirements

3.12.2.1 Fine Aggregate

a. Grading. At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136 and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits.

b. Corrective Action for Fine Aggregate Grading. When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall be immediately reported to the Contracting Officer, paving shall be stopped, and immediate steps taken to correct the grading.

3.12.2.2 Coarse Aggregate

a. Grading. At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt approved limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling.

b. Corrective Action for Grading. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer, and steps taken to correct the grading. Where two consecutive averages of 5 tests are outside specification limits, the operation shall be considered out of control and shall be reported to the Contracting Officer, paving shall be stopped, and immediate steps shall be taken to correct the grading.

3.12.2.3 Quality of Aggregates

Thirty days prior to the start of concrete placement, the Contractor shall perform all tests specified for aggregate quality, including deleterious materials. In addition, after the start of paving, the Contractor shall perform similar tests for aggregate quality at least once every month, and when the source of aggregate or aggregate quality changes. Testing interval may be increased to three months when the previous two tests indicate the aggregate meets all quality requirements. Samples tested after the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

3.12.2.4 Scales, Batching and Recording

a. Weighing Accuracy. The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every month for conformance with specified requirements. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

b. Batching and Recording Accuracy. Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required mass, recorded mass, and the actual mass batched. The Contractor shall test and ensure that the devices for dispensing admixtures are operating properly and accurately.

c. Corrective Action. When either the weighing accuracy or batching accuracy does not comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

3.12.2.5 Batch-Plant Control

The measurement of all constituent materials including cementitious materials, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate masses and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. The amount of air-entraining agent shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water masses per cubic meter, amount of water as free moisture in each size of aggregate, and the batch aggregate and water masses per cubic meter for each class of concrete batched during each day's plant operation.

3.12.2.6 Concrete Mixture

a. Air Content Testing. Air content tests shall be made when test specimens are fabricated. In addition, at least two other tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of paving. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Tests shall be made in accordance with ASTM C 231. Test results shall be plotted on control charts which are kept current and shall, at all times, be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single test result reaches either the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the batch to plot on both the air content and the control chart for range, and for determining need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate control chart for each mixture on which an average line is set at the midpoint of the specified air content range from paragraph SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES. An upper warning limit and a lower warning limit line shall be set 1.0 percentage point above and below the average line, respectively. An upper action limit and a lower action limit line shall be set 1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a secondary control chart for range where an upper warning limit is set at 2.0 percentage points and an upper action limit is set at 3.0 percentage points. Samples for air content shall be taken at the paving site. The Contractor shall deliver the concrete to the paving site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the paving site, correlation samples shall be taken at the paving site as required by the Contracting Officer, and the air content at the mixer controlled as directed.

b. Air Content Corrective Action. Whenever points on the control chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the secondary control chart for range reaches the warning limit, the admixture dispenser shall be recalibrated to insure that it is operating accurately and with good reproducibility. Whenever a point on either control chart (single test or result of two tests made concurrently, as specified above) reaches an action limit line, the air content shall be considered out of control and the paving operation shall immediately be halted until the air content is under control. Additional air content tests shall be made when paving is restarted.

c. Slump Testing. Slump tests shall be made when test specimens are fabricated. In addition, at least four other slump tests shall be made on randomly selected batches in accordance with ASTM C 143

for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Test results shall be plotted on control charts which shall at all times be readily available to the Government and shall be submitted weekly. Copies of the current control charts shall be kept in the field by testing crews and results plotted as tests are made. When a single slump test reaches or goes beyond the upper action limit, a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the slump of the batch to plot on both the control chart for slump and the chart for range, and for determining need for any remedial action. An upper warning limit shall be set at 12 mm below the maximum allowable slump on separate control charts for slump used for each type of mixture as specified in paragraph, SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES, and an upper action limit line shall be set at the maximum allowable slump, as specified in the same paragraph for fixed form paving or as selected by the Contractor at the start of the project for slipform paving. The range between each consecutive slump test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at 38 mm. Samples for slump shall be taken at the paving site. The Contractor is responsible for delivering the concrete to the paving site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between the mixer and the paving site, correlation samples shall be taken at the paving site as required by the Contracting Officer, and the slump at the mixer controlled as directed.

d. Slump Corrective Action. Whenever points on the control charts for slump reach the upper warning limit, an approved adjustment shall immediately be made in the batch masses of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum w/c specified, based on aggregates which are in a saturated surface dry condition. When a slump result (average of two tests made concurrently, as specified above) exceeds the upper action limit, no further concrete shall be delivered to the paving site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no adjustment of batch masses, produce a point on the control chart for range at or above the upper action limit, the paving operation shall immediately be halted, and the Contractor shall take approved steps to bring the slump under control. Additional slump tests shall be made as directed.

e. Temperature. The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064. The temperature shall be reported along with the compressive strength data.

3.12.2.7 Concrete Strength Testing for CQC

Contractor Quality Control operations for concrete strength shall consist

of the following steps:

a. Take samples for strength tests at the paving site. Fabricate and cure test beams in accordance with ASTM C 31/C 31M; test them in accordance with ASTM C 78.

b. [AM #1] Samples for flexural strength specimens shall be taken once for every 153 cubic meters placed, two specimens per test age (7 and 28 days) shall be taken.

c. [AM #1] Not used.

d. [AM #1] Not used.

e. [AM #1] Not used.

f. [AM #1] Not used.

g. The Contractor's CQC testing agency shall maintain up-to-date control charts for strength, showing the 7-day CQC flexural strength, the 14-day flexural strength (from acceptance tests) and the 28-day flexural strength of each of these for each lot.

3.12.2.8 Inspection Before Placing

Underlying materials, construction joint faces, forms, reinforcing, dowels, and embedded items shall be inspected by the Contractor in sufficient time prior to each paving operation in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

3.12.2.9 Paving

a. Paving Inspection. The placing foreman shall supervise all placing and paving operations, shall determine that the correct quality of concrete is placed in each location as shown and that finishing is performed as specified; shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume of concrete placed, and method of paving and any problems encountered.

b. Placing and Paving Corrective Action. The paving foreman shall not permit batching and paving to begin until it has been verified that an adequate number of vibrators in working order and with competent operators are available. Paving shall not be continued if piles of concrete exist or if the concrete is inadequately consolidated or if surface finish is not satisfactory. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.12.2.10 Vibrators

a. Vibrator Testing and Use. The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when paving is in progress. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the

concrete. The frequency shall be determined while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing.

b. Vibrator Corrective Action. Any vibrator not meeting the requirements of subparagraphs, Paver-Finisher and Consolidation, shall be immediately removed from service and repaired or replaced.

3.12.2.11 Curing Inspection

a. Membrane Curing Inspection. No curing compound shall be applied until the Contractor has verified that the compound is properly mixed and ready for spraying. At the end of each day's operation, the quantity of compound used shall be determined by measurement of the container and the area of concrete surface covered; the Contractor shall then compute the rate of coverage in square meters per L and shall also note whether or not coverage is uniform. All this shall be reported daily.

b. Membrane Curing Corrective Action. When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

3.12.2.12 Hot/Cold-Weather Protection

At least once each shift and once per day on non-work days, an inspection shall be made of all areas subject to hot/cold-weather protection. Any deficiencies shall be noted, corrected, and reported.

3.12.2.13 Mixer Uniformity

a. Stationary Mixers. Prior to the start of concrete placing and once every 4 months when concrete is being placed, or once for every 38,000 cubic meters of concrete placed, whichever results in the longest time interval, uniformity of concrete mixing shall be determined in accordance with COE CRD-C 55. The original test shall be a Regular Test. After the mixing operation has been tested and approved, subsequent tests shall be Abbreviated Tests.

b. Truck Mixers. Prior to the start of concrete placing and at least once every 4 months when concrete is being placed, uniformity of concrete mixing shall be determined in accordance with ASTM C 94. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.

c. Mixer Uniformity Corrective Action. When a mixer fails to meet mixer uniformity requirements, either the mixing time shall be increased, batching sequence changed, batch size reduced, or

adjustments shall be made to the mixer until compliance is achieved. After adjustments have been made, another uniformity test shall be made.

3.12.2.14 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of hot/cold-weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

-- End of Section --

SECTION 02770

CONCRETE SIDEWALKS AND CURBS AND GUTTERS
03/98
Amendment #0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(1991) Burlap Cloth Made from Jute or Kenaf

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185	(1994) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 615/A 615M	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A 616M	(1996) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617/A 617M	(1996a) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM C 31/C 31M	(1996) Making and Curing Concrete Test Specimens in the Field
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 171	(1997) Sheet Materials for Curing Concrete
ASTM C 172	(1990) Sampling Freshly Mixed Concrete
ASTM C 173	(1996) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 309	(1997) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 3405	(1996) Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements

CORPS OF ENGINEERS (COE)

COE CRD-C 527	(1988) Standard Specification for Joint Sealants, Cold-Applied, Non-Jet-Fuel-Resistant, for Rigid and Flexible Pavements

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Field Quality Control; FIO.

Copies of all test reports within 24 hours of completion of the test.

SD-18 Records
Concrete; FIO.

Copies of certified delivery tickets for all concrete used in the construction.

1.3 WEATHER LIMITATIONS

1.3.1 Placing During Cold Weather

Concrete placement shall be discontinued when the air temperature reaches 5 degrees C and is falling. Placement may begin when the air temperature reaches 2 degrees C and is rising. Provisions shall be made to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 2 degrees C, placement shall be approved in writing. Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water and aggregates shall be heated as necessary to result in the temperature of the in-place concrete being between 10 and 30 degrees C. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 10 degrees C for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.3.2 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed 30 degrees C except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed 35 degrees C.

1.4 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.4.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Contracting Officer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.4.2 Slip Form Equipment

Slip form paver or curb forming machine, will be approved based on trial use on the job and shall be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in 1 pass.

PART 2 PRODUCTS

2.1 CONCRETE

Concrete shall conform to the applicable requirements of Section 02753 CONCRETE PAVEMENT FOR HEAVY-DUTY PAVEMENTS except as otherwise specified. Concrete shall have a minimum compressive strength of 24 MPa at 28 days. Maximum size of aggregate shall be 37.5 mm.

2.1.1 Air Content

Mixtures shall have air content by volume of concrete of [AM #1] 3-5 percent plus or minus 1 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

The concrete slump shall be [AM #1] 75 millimeters where determined in accordance with ASTM C 143.

2.1.3 Reinforcement Steel

Reinforcement bars shall conform to ASTM A 615/A 615M, ASTM A 616/A 616M, or ASTM A 617/A 617M. Wire mesh reinforcement shall conform to ASTM A 185.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

2.2.3 White Pigmented Membrane-Forming Curing Compound

White pigmented membrane-forming curing compound shall conform to ASTM C 309, Type 2.

2.3 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

2.4.2 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 9.5 mm (3/8 inch) thick, unless otherwise indicated.

2.5 JOINT SEALANTS

2.5.1 Joint Sealant, Cold-Applied

Joint sealant, cold-applied shall conform to COE CRD-C 527.

2.5.2 Joint Sealant, Hot-Poured

Joint sealant, hot-poured shall conform to ASTM D 3405.

2.6 FORM WORK

Form work shall be designed and constructed to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 50 mm (2-inch) nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 3 m (10 feet). Radius bends may be formed with 19 mm (3/4-inch) boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 3 m (10 feet) with a minimum of 2 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with

steel forms.

2.6.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

2.6.2 Curb and Gutter Forms

Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 3 m or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 38 mm (1-1/2 inch) benders, for the full height of the curb, cleated together.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted in conformance with Section 02300 EARTHWORK.

3.1.1 Sidewalk Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms. Additionally, one density test per 55 square meters shall be performed.

3.1.2 Curb and Gutter Subgrade

The subgrade or underlying course shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade or underlying course shall be of materials equal in bearing quality to the subgrade or underlying course under the adjacent pavement. Additionally, one density test per 30 meters shall be performed on aggregate base course placed under curb and gutter.

3.1.3 Maintenance of Subgrade

The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

3.2 FORM SETTING

Forms shall be set to the indicated alignment, grade and dimensions. Forms shall be held rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 1.2 meters. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or

heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Forms for sidewalks shall be set with the upper edge true to line and grade with an allowable tolerance of 3 mm in any 3 m long section. After forms are set, grade and alignment shall be checked with a 3.05 m (10 foot) straightedge. Forms shall have a transverse slope of 20 millimeters per meter with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

3.2.2 Curbs and Gutters

The forms of the front of the curb shall be removed not less than 2 hours nor more than 6 hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished, as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Concrete shall be placed in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a wood float, bull float, or darby, edged and broom finished.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic.

3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished with an edger having a radius of 3 mm. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 7.9 mm (5/16 inch) from the

testing edge of a 3.05 m (10-foot) straightedge. Permissible deficiency in section thickness will be up to 6.4 mm (1/4 inch).

3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

See Section 02753 CONCRETE FOR HEAVY-DUTY PAVEMENTS for monolithic curbs.

3.4.1 Formed Curb and Gutter

Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule".

3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 13 mm. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

3.4.4 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

3.4.5 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 6.4 mm (1/4 inch) from the testing edge of a 3.05 m (10-foot) straightedge. Permissible deficiency in section thickness will be up to 6.4 mm (1/4 inch).

3.5 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 1.5 m on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 3 m or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated.

3.5.1 Sidewalk Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of

the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 3 mm (1/8 inch) blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

Expansion joints shall be formed with 12.7 mm joint filler strips. Joint filler shall be placed with top edge 6 mm below the surface and shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 3 mm, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and filled with joint sealer. Joints shall be sealed as specified in Section 02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS.

3.5.3 Reinforcement Steel Placement

Reinforcement steel shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed.

3.6 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 1.5 m nor greater than 4.5 m in length. Contraction joints shall be constructed by means of 3 mm thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

3.6.2 Expansion Joints

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, expansion joints at least 12.7 mm in width shall be provided at intervals not exceeding 35 meters. Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. Joints shall be sealed as specified in Section 02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS.

3.7 CURING AND PROTECTION

3.7.1 General Requirements

Concrete shall be protected against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Unhardened concrete shall be protected from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.7.1.1 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 150 mm. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.7.1.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 300 mm when a continuous sheet is not used. The curing medium shall not be less than 450 mm wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

3.7.1.3 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 5 square meters per liter (200 square feet per gallon) for both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of

the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Completed concrete shall be protected from damage until accepted. The Contractor shall repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

3.8 FIELD QUALITY CONTROL

3.8.1 General Requirements

The Contractor shall perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, the Contractor shall take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

The Contractor shall provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 190 cubic meters of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31/C 31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 4 MPa.

3.8.2.2 Air Content

Air content shall be determined in accordance with ASTM C 173 or ASTM C 231. ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Two slump tests shall be made on randomly selected batches of each class of concrete for every 190 cubic meters, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior to concrete placement and the thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 6 mm the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 6 mm. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Government and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

-- End of Section --

SECTION 03405

PRESTRESSED CONCRETE BRIDGE GIRDERS - RAILROAD BRIDGE
03/99
AMENDMENT NO. 0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

(AM#1) AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

(AM#1) AREA-01 **(AM#1) (1999) 1997-1998 Manual for Railway Engineering (4 Vol.)**

PART 2 PRODUCTS

2.1 GENERAL

Prestressed concrete bridge girders shall conform to the applicable requirements of chapter 8 of AREA Manual for Railway Engineering. All materials, fabrication, transporting, and erection are included.

PART 3 EXECUTION

3.1 PAYMENT

No direct measurement or payment will be made for the work performed and material furnished, but these shall be considered subsidiary to the various bid items called for in the contract.

-- End of Section --

SECTION 05325

HANDRAILS - RAILROAD BRIDGE
03/99
AMENDMENT NO. 0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN RAILWAY ENGINEERING ASSOCIATION (AREA)**(AM#1)** **AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)**

(AM#1) **AREA-01** **(AM#1)** **(1999) 1997-1998 Manual for Railway Engineering (4 Vol.)**

PART 2 PRODUCTS

2.1 GENERAL

Walkway Handrails shall conform to the applicable requirements of Chapter 15, paragraph 8.5 of AREA Manual for Railway Engineering and Detail as shown on plans.

PART 3 EXECUTION

3.1 MEASUREMENT AND PAYMENT

No direct measurement or payment will be made for the work to be done, materials to be furnished or for the equipment, labor and incidentals necessary to complete this work, but these shall be considered subsidiary to the various bid items called for in this contract.

-- End of Section --

SECTION 05650

RAILROADS
09/98
Amendment #0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN RAILWAY ENGINEERING **AND MAINTENANCE-OF-WAY** ASSOCIATION (**AREMA**)

AREA-01	(1999) Manual for Railway Engineering 4 Vol.
AREA-02	(1999) Portfolio of Track Work Plans

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(1993) High-Strength Bolts for Structural Steel Joints (Metric)
ASTM A 490	(1997) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A 490M	(1993) High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM C 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates

ASTM C 142	(1978; R 1990) Clay Lumps and Friable Particles in Aggregates
ASTM C 535	(1996) Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 702	(1993) Reducing Samples of Aggregate to Testing Size
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 217	(1994) Cone Penetration of Lubricating Grease (IP50/88)
ASTM D 402	(1994) Distillation of Cut-Back Asphaltic (Bituminous) Products
ASTM D 445	(1996) Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity)
ASTM D 566	(1993) Dropping Point of Lubricating Grease
ASTM D 1241	(1968; R 1994) Materials for Soil-Aggregate Subbase, Base, and Surface Courses
ASTM D 1310	(1986; R 1997) Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 1683	(1990a) Failure in Sewn Seams of Woven Fabrics
ASTM D 2171	(1994) Viscosity of Asphalts by Vacuum Capillary Viscometer
ASTM D 3740	(1996) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 3776	(1996) Mass Per Unit Area (Weight) of Woven Fabric
ASTM D 4354	(1996) Sampling of Geosynthetics for Testing
ASTM D 4355	(1992) Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D 4491	(1995) Water Permeability of Geotextiles

	by Permittivity
ASTM D 4533	(1991; R 1996) Trapezoid Tearing Strength of Geotextiles
ASTM D 4595	(1986; R 1994) Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D 4632	(1991; R 1996) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4716	(1995) Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products
ASTM D 4751	(1995) Determining Apparent Opening Size of a Geotextile
ASTM D 4759	(1988; R 1996) Determining the Specification Conformance of Geosynthetics
ASTM D 4791	(1995) Flat Particles, Elongated Particles, or Flat and Elongated in Coarse Aggregate
ASTM D 4833	(1988; R 1996) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes
ASTM F 405	(1996) Corrugated Polyethylene (PE) Tubing and Fittings
ASTM F 512	(1993) Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1996) Structural Welding Code - Steel

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C2	(1995) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
AWPA C6	(1995) Cross Ties and Switch Ties Preservative Treatment by Pressure Processes
AWPA M2	(1995) Standard for Inspection of Treated Timber Products
AWPA M6	(1995) Brands Used on Forest Products

AWPA P2 (1995) Standard for Creosote Solutions

FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA SA-89-006 (1988) Manual on Uniform Traffic Control Devices for Streets and Highways

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Wood Ties; FIO.

Name of the tie manufacturer, Rail Tie Association membership, the wood species proposed, the quantities of ties for each specie proposed, and product data for the ties to be furnished, including the type of seasoning to be utilized, prior to ordering the ties

New Jointed Rail; GA. Relay Rail; GA. Joint Bars; FIO. Compromise Joint Bars; FIO.

Manufacturer's data on new rail including: rail weight, rail section, drilling, rail length, date rolled, and the name of the mill where the rail was rolled. For relay rail the required information shall include weight, section, lengths, and the name of the supplier. The maximum allowable vertical wear on the rail head and the maximum allowable horizontal wear on the side of the rail shall be provided. The design of the joint bars and compromise joint bars proposed to be furnished with each rail section shall also be provided.

Miscellaneous Track Materials; FIO.

Manufacturer's data for all track materials to be furnished.

Crossing Material or Surface; FIO.

Within 30 days of the Notice to Proceed, the brand name of the premanufactured crossing material or crossing surface material proposed for use along with manufacturer's literature concerning the product; and for built-in-place crossings, the type of materials to be used along with manufacturer's literature.

Components or Products; GA.

Performance data for components or products proposed as an equivalent to those specified. The Contracting Officer's written approval is required for any such equivalent type component or product proposed to be used.

SD-07 Schedules

Materials and Equipment; FIO.

A complete schedule of the materials proposed for installation within 60 days of receipt of notice to proceed, and before installation of the materials; the schedule shall include a list of equipment proposed for the work.

SD-08 Statements

Traffic Detour Plans; GA.

Traffic detour plans for approval.

Crossing Material or Surface; FIO.

Detailed installation procedure for the premanufactured crossing material or crossing surface material proposed for use within 30 days of the notice to proceed.

Thermite Welding Procedures; GA.

A detailed statement covering the step-by-step procedures to be employed in making the welds, including a complete description of each of the following items, as applicable, and any other essential characteristics included in the welding procedures:

a. The manufacturer's trade name for the welding process.

b. The method used for cutting and cleaning the rail ends. Flame cutting of rail ends will not be allowed.

c. The minimum and maximum spacing between rail ends.

d. The method used for maintaining the rails in alignment during welding.

e. The method used for preheating, including time and temperature.

f. The tapping procedure, including the minimum time required to cool the weld under the mold insulation.

g. The method used, including a description of special tools and equipment, for removing the upset metal and finishing the weld to the final contour.

h. Quality control procedures to be followed.

i. The contractual agreements with any subcontractor employed by the Contractor in doing the work.

SD-09 Reports

Sampling and Testing; FIO.

One certified copy of Test Reports for each test performed on the ballast and subballast within 2 working days of the test completion.

Wood Ties; FIO.

Certified test and inspection reports for crossties and switch ties subsequent to treatment, a minimum of seven calendar days prior to any ties being installed in track. Test and inspection reports shall contain the information required by Part 7 of AWPA M2.

Geotextiles; FIO.

Independent testing laboratory's certified test reports for geotextiles, including necessary analysis and interpretation. These reports shall provide results of the laboratory testing performed on samples of the geotextile material delivered to the jobsite. Test reports shall be submitted at least 60 working days prior to the installation of the geotextile.

Ultrasonic Test; FIO.

Results of the ultrasonic rail testing. Results shall list defects and rail stationing.

SD-13 Certificates

Wood Ties; FIO.

Certificates of compliance prior to any ties being installed in track.

Ballast; FIO. Subballast; FIO.

Certificates of Compliance for the ballast and subballast materials to be installed in this project.

Materials and Equipment; FIO.

Manufacturer's certificates of conformance for the following materials:

a. Rail.
b. Tie plates.
c. Track bolts, nuts, and spring washers.
d. Joint bars.
e. Rail anchors.
f. Track spikes.
g. Turnouts.
h. N/A.
i. Premanufactured car bumpers.
j. Rail welding process.

SD-14 Samples

Geotextile; FIO.

Geotextile samples for testing. Samples shall be submitted a minimum of 60 days prior to the beginning of installation of the geotextiles. One sample shall be provided for each 20 units (rolls, panels, etc.) of geotextile to be used in the contract. All samples shall be from the same production lot as will be supplied for the contract. Samples shall be identified by the manufacturer's name, brand name, lot designation, and project name. The

minimum size of sample submitted for testing shall be the full width of the geotextile by 1.7 m .

Ballast and Subballast Samples; FIO.

Samples of the ballast and subballast material for testing. Samples shall be submitted a minimum of 60 days prior to the installation of the material. Samples shall be obtained from the quarry, supplier, or other source that will be used to provide the ballast and subballast materials for this project using the methods described in ASTM D 75. One representative sample of not less than 90.6 kg (200 lbs) of ballast material shall be submitted for each 9070 MT of ballast to be installed. One representative sample of not less than 90.6 kg (200 lbs) of subballast material shall be submitted for each 9070 MT of subballast to be installed.

SD-18 Records

Record of Field Weld; FIO.

A welding record of each field weld on the form attached at the end of this section. The original copies of the form bearing the signatures and initials of personnel involved shall be submitted as part of the Project Record Documents.

Table VII; FIO.

A record of the items repaired or rebuilt by the electric arc welding method and grinding as shown on Table VII at the end of this section.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Materials and Samples

The Contracting Officer will notify the Contractor of the materials approved or disapproved. Disapproved materials that have already been delivered to the project site, shall be promptly segregated from the approved materials and removed from the premises. If materials are disapproved, acceptable replacement materials shall be provided at no additional cost to the Government. Initial approval by the Contracting Officer will not prevent the removal and replacement of materials that are materially defective or materials not meeting this specification that are discovered during construction and/or routine quality control/quality assurance operations.

1.3.2 Geotextiles

Geotextiles shall be shipped and stored in their original ultraviolet resistant cover until the day of installation. Geotextiles shall be protected from vandalism, temperatures greater than 60 degrees C, dirt, dust, mud, debris, moisture, sunlight, and ultraviolet rays. Geotextiles delivered to the project site shall be clearly labeled on the material cover to show the manufacturer's name, brand name, fabric type, location and date manufactured, lot identification, width, and length.

1.4 QUALIFICATIONS

1.4.1 Track Construction

Track construction shall be performed under the direction of qualified and competent supervisory personnel experienced in railroad construction.

1.4.2 Welding

Welding shall be performed under the direct supervision of an experienced welding supervisor or foreman.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Temporary Work

During construction, suitable roads and crossings with all necessary lights, signs, drainage, and other appurtenances required for safe public and local travel shall be provided. Suitable temporary fences shall be erected and maintained where required to prevent trespass upon work or damage to adjoining property. Drainage shall be maintained, and the accumulation of water that might affect the stability of the roadbed will not be permitted.

1.5.2 Welding

Welding shall not be performed in rain, snow, or other inclement weather without adequately protecting the weld from the elements.

1.5.3 License Agreement

The work under this contract, within the right-of-way limits, is being accomplished under a license agreement between the Burlington Northern Santa Fe RAIL CORPORATION and the UNITED STATES OF AMERICA. See Attachment at the end of this Section.

PART 2 PRODUCTS

2.1 BALLAST

Prepared ballast shall be crushed stone, Size No. 4, or 5 conforming to Chapter 1, Part 2, of AREA-01 for quality, soundness and gradation. In the portion retained on each sieve specified, the crushed stone shall contain at least 90 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the plane. When two fractures are contiguous, the angle between planes of the fractures shall be at least 30 degrees in order to count as two fractured faces. Ballast materials shall meet the property requirements shown in TABLE I.

TABLE I. MINIMUM PROPERTY REQUIREMENTS - BALLAST

Property	Maximum Value	Minimum Value	Test Method
Percent passing 0.075 sieve (No. 200 Sieve)			ASTM C 117
Granite	1.0%	--	
Traprock	1.0%	--	
Quartzite	1.0%	--	
Dolomitic Limestone	1.0%	--	

TABLE I. MINIMUM PROPERTY REQUIREMENTS - BALLAST

Property	Maximum Value	Minimum Value	Test Method
Bulk specific gravity			ASTM C 127
Granite	--	2.60	
Traprock	--	2.60	
Quartzite	--	2.60	
Dolomitic Limestone	--	2.65	
Absorption			ASTM C 127
Granite	1.0	--	
Traprock	1.0	--	
Quartzite	1.0	--	
Dolomitic Limestone	2.0	--	
Clay lumps and friable particles			ASTM C 142
Granite	0.5%	--	
Traprock	0.5%	--	
Quartzite	0.5%	--	
Dolomitic Limestone	0.5%	--	
Degradation Soundness			See Note 1
Granite	35%	--	
Traprock	25%	--	
Quartzite	30%	--	
Dolomitic Limestone	30%	--	
Sodium sulfate - 5 cycles			ASTM C 88
Granite	5%	--	
Traprock	5%	--	
Quartzite	5%	--	
Dolomitic Limestone	5%	--	
Flat or elongated particles			USACE CRD-C-119
Granite	5%	--	
Traprock	5%	--	
Quartzite	5%	--	
Dolomitic Limestone	5%	--	

Note #1 - Materials having gradations containing particles retained on the 25 mm sieve shall be tested by ASTM C535. Materials having gradations with 100% passing the 25 mm sieve shall be tested by ASTM C131.

Note #2 - The limit for bulk specific gravity is a minimum value. Limits for the remainder of the tests are maximum values.

TABLE I. MINIMUM PROPERTY REQUIREMENTS - BALLAST

Property	Maximum Value	Minimum Value	Test Method

2.2 SUBBALLAST

Subballast shall consist of the same material used for ballast conforming to an ASTM D 1241 Type I, Gradation D mixture as approved.

2.3 GEOTEXTILE

2.3.1 Physical Property Requirements

The geotextile shall be a nonwoven, needle-punched material. The geotextile's fiber shall consist of at least 85 percent by weight polyester, polyamide, polypropylene, or polyethylene. The geotextile shall contain stabilizers and/or inhibitors as necessary to make the filaments resistant to deterioration from ultraviolet light and heat exposure, particularly prior to placement and coverage. The fibers shall be formed into a network which will be dimensionally stable. The edges of the geotextile shall be finished in a way to prevent the outer fibers from being pulled away from the geotextile. The geotextile shall exceed the applicability property requirements stated in TABLE II.

TABLE II - PROPERTY REQUIREMENTS-GEOTEXTILE

PROPERTY	MINIMUM REQUIREMENTS*	TEST METHOD
Weight**	0.57 kg/0.836 sq m (15 oz/sq yd)	ASTM D 3776 Option B
Color	Grey or tinted	--
Grab tensile strength	158.6 kg (350 lbs)	ASTM D 4632
Puncture strength	83.8 kg (185 lbs)	ASTM D 4833
Trapezoidal tear strength	68 kg (150 lbs)	ASTM D 4533
Apparent opening size (AOS) (maximum required value)	Less than 0.22 mm (No. 70 sieve)	ASTM D 4751
Normal permeability (k)	0.1 cm/sec	ASTM D 4491
Permittivity	0.2 per sec	ASTM D 4491
Planar water flow/ transmissivity at i = 1 and normal stress = 1.6 kg per sq cm (3.5 psi)	5.53 sq cm/min (0.006 sq ft/min)	ASTM D 4716
Ultraviolet degradation at 150 hours	70 percent strength retained	ASTM D 4355

TABLE II - PROPERTY REQUIREMENTS-GEOTEXTILE

PROPERTY	MINIMUM REQUIREMENTS*	TEST METHOD
Seam strength	158.6 kg (350 lbs)	ASTM D 1683

*These property requirements are Minimum Average Roll Values in the weaker principal direction.

**Geotextile selection shall not be limited by the minimum weight shown. Selection shall be based on the other property requirements listed. Heavier geotextiles have shown greater resistance to abrasion.

2.3.2 Dimensional Requirements

Each roll of geotextile shall be at least 3 m wide and 6 m long.

2.4 JOINT BARS

Joint bars shall be of the size, shape, and punching pattern to fit the rail being joined.

2.4.1 New Joint Bars

New joint bars shall be used with new rail, and shall be of the "toeless" and head to match rail section. New joint bars shall conform to the requirements of "Specifications For High-Carbon Steel Joint Bars" or "Specifications For Quenched Carbon-Steel Joint Bars and Forged Compromise Joint Bars" found in Chapter 4, Part 2 of AREA-01 for the joint bar and assemblies recommended in Chapter 4, Part 1 of AREA-01.

2.4.2 Used Joint Bars

Used joint bars in good condition shall be used with relay rail only. The type of joint bar shall be "toeless" Used joint bars shall be straight, free from cracks, breaks, and other visual defects. Excessive rust, dirt, and other foreign materials on the joint bars are not permitted. Used joint bars shall be of the proper size to make good contact with the underside of the rail head and the top of the rail base on the rails being joined. Joint bars shall have alternating round and oval bolt holes. Bolt holes shall not show excessive wear that would prevent use of the oval neck track bolt normally used with that joint bar. Joint bars that have been flame-gouged, flame cut, or otherwise altered shall be considered scrap and shall not be used.

2.4.3 Compromise Joint Bars

Compromise joint bars shall be of the size, shape, and punching pattern to fit the rail sizes and sections being joined. Only factory designed and constructed (forged or cast) compromise joint bars shall be used to join rails of different sizes.

2.4.3.1 New Compromise Joint Bars

Compromise joint bars shall conform to the requirements of "Specifications For Quenched Carbon-Steel Joint Bars and Forged Compromise Joint Bars"

found in Chapter 4, Part 2 of AREA-01.

2.4.3.2 Used Compromise Joint Bars

Requirements for joint bars in paragraph Used Joint Bars shall also apply to used compromise joint bars.

2.5 GREASE

Grease for lubricating moving parts in turnouts and other trackwork shall have the following typical characteristics:

Calcium Soap, percent	9.0
Solid Additive (Graphite),percent	11.5
Penetration, ASTM D 217 at 25 degrees C worked	340
Dropping Point ASTM D 566 at 25 degrees C	101/214
Oil Viscosity, square mm/record at 40 degrees C	81.8
ASTM D 445 SUS at 38 degrees C	379

Other types of grease or lubricating oil may be used provided that the grease or oil has been used successfully by local commercial railroads and has the approval of the Contracting Officer.

2.6 OIL FOR CORROSION PROTECTION

Oil for protecting rail and other track materials from corrosion, except joints, shall conform to the following general specification:

Asphalt, 100 penetration minimum 45 percent	ASTM D 402
Flash point, minimum 55 degrees C	ASTM D 1310
Viscosity, kinematic, 60 degrees C 480 to 700 sq mm/s	ASTM D 2171

2.7 RAIL

2.7.1 New Jointed Rail

New jointed rail shall comply with the following:

a. Rail Lengths: New rail shall be a 57 kg/m (115 lbs/yd), 65 kg/m (132 lbs/yd) or 67 kg/m (136 lbs/yd) section and shall conform to the specifications in Chapter 4, Parts 1 and 2 of AREA-01 that were in effect at the time of its manufacture. New rail shall be provided in 11.9 or 24.4 m lengths.

b. Rail Drilling: New rail shall be provided with the rail ends drilled. Drilling shall be uniform and to the patterns specified.

RAIL	DRILLING
115 RE	89-152-152 mm (3-1/2, 6, 6 inch)
132 RE	89-152-152 mm (3-1/2, 6, 6 inch)
133 RE	89-152-152 mm (3-1/2, 6, 6 inch)
136 RE	89-152-152 mm (3-1/2, 6, 6 inch)

2.7.2 Used Jointed Rail

2.7.2.1 Relief Rail

Used rail for spot rail replacement of defective rails (relief rail) shall be the same weight, section, drilling, and length as the rail being replaced. Relief rail shall meet the requirements specified for relay rail.

2.7.2.2 Relay Rail

Relay rail shall be control cooled. Used rail for out of face replacement and new construction shall be 45 kg/m or heavier and shall have the same section and drilling pattern for each rail weight. Acceptable rail weights and sections are: 115 AREA, 132 AREA, and 136 AREA. All relay rail provided shall be the same section.

a. Rail Drilling: Relay rail shall be provided with the rail ends drilled. Drilling shall be uniform and to the patterns specified.

RAIL	DRILLING
115 RE	89-152-152 mm (3-1/2, 6, 6 inch)
132 RE	89-152-152 mm (3-1/2, 6, 6 inch)
133 RE	89-152-152 mm (3-1/2, 6, 6 inch)
136 RE	89-152-152 mm (3-1/2, 6, 6 inch)

b. Length: Relay rail shall be standard 11.9 m lengths. Not more than 10 percent of the lot may be shorts. No rail shorter than 8.2 m will be accepted.

c. Maximum Allowable Wear: For each rail, the average top wear shall meet the requirements on Table IV, except rail in turnouts which shall conform to paragraph Maximum Wear Used Rails Installed in Turnouts. Side wear shall be measured 16 mm below the original top of rail.

d. Condition and Appearance: Relay rail shall be free from obvious defects and clean in appearance. Rail that has severe pitting and corrosion or has been flame-gouged, or spike nipped will not be accepted. Rail shall be straight from line and surface and free from any kinks or bends. Rail bases shall be solid and free from visual defects such as plate wear, spike notching, pitting, and flame-gouging.

(1) Maximum Allowable Lip: Lip or overflow shall not exceed 3 mm on either side of the rail head.

(2) Engine Burns: Engine burns shall not be greater than 13 mm diameter and 0.8 mm deep. A maximum of 6 engine burns is allowed

per rail and engine burns shall not affect more than 25 percent of the total order.

(3) End Batter and Chipping: Rail end batter shall not exceed a maximum of 3 mm when measured 13 mm from the rail end with a 460 mm straightedge laid only on the rail being measured. Chipped or broken rail ends will not be accepted.

(4) Running Surface Damage: Running surface damage shall not exceed 6 mm long by 13 mm wide, and shall be not greater than 1.5 mm deep. Flat spots are not permitted on the rail head.

(5) Defects Not Permitted: Relay rail having any of the following defects shall not be accepted: bolt hole cracks or breaks, broken base, breaks, crushed head, detail fracture, engine burn fracture, head-web separation, piped rail, horizontal split head, vertical split head, torch cut rail ends, torch cut bolt holes, and compound or transverse fissures. The presence of any of these defects in the rail render that rail as scrap.

Nominal Rail	Maximum Allowable Wear, mm	
Weight, kg/m	Top	Side
57.0	3.2	6.4
Greater than 57.0	6.4	9.5

2.8 TIE PLATES

2.8.1 General

Tie plates shall be of the dimensions and punching pattern (A or B) to fit the rail. New tie plates conforming to Chapter 5, Part 1 of AREA-01 shall be used with new rail. Used tie plates in good condition may be used with relay rail. The used tie plates shall not be smaller than 190.5 by 279 mm double-shoulder for use with relay rail having nominal weights of 49.6 kg/m and greater. Both flat and canted plates will be required to match the existing tie plates that are in track. Canted tie plates shall be used in all new rail and relay out-of-face rail replacements.

2.8.2 Used Tie Plates

Used tie plates shall be free from excessive rust, pitting, mechanical damage, and dirt and other foreign materials. Cracked or broken plates shall be considered as scrap and shall not be used. Shoulders on the tie plates shall project a minimum of 6 mm above the plane of the rail seat. The thickness of the tie plate shall be at least 13 mm when measured anywhere in the rail seat area. Spike holes shall be square and not corroded, worn, or mechanically enlarged.

2.9 WOOD TIES

Species shall be Ash, Beech, Red and White Oak. Switch ties shall be Ash or Oak. Conditioning and seasoning shall conform to the requirements of AWPA C6 for the individual wood species. Ties shall be well seasoned. Prior to preservative treatment, wood ties shall be dried to the oven dry moisture content, or less, as specified in paragraph 3.14 of AWPA C6. The

wood may be air dried, vapor dried, or boultonized. Ties which are to be dried by artificial means shall be conditioned and treated as soon as possible after sawing, but no more than 30 days later. The temperature used for boultonizing shall be as high as possible but in no case less than 94 degrees C. Vapor dried ties shall be transferred from drying cylinders to treatment cylinders as quickly as possible to avoid loss of heat from the seasoned ties. Ties shall be pressure treated in accordance with Chapter 3, Part 6 of AREA-01 by the empty cell process with a 60/40 creosote/coal tar solution (Grade C) in accordance with AWPA P2 to a minimum retention of 3.6 kg/0.28 cu m (8 lbs/cu ft) of wood. Bridge ties shall be treated in accordance with paragraph Bridge Ties. The Contractor shall record treatment as specified in AWPA M2. Treated ties shall be permanently marked or branded by the producer in accordance with AWPA M6. Ties shall be produced by a member of the Railway Tie Association. All ties shall be incised on all four sides in the pattern specified in AREA-01, Chapter 3, Part 6, prior to treatment. Splits shall not be longer than 100 mm and not wider than 5 mm at either end. Splits longer than 100 mm but not longer than the width of the face in which the split appears, will be acceptable if specified anti-splitting devices are installed with the splits compressed. Any required adzing and drilling for spikes shall be performed prior to treatment. The Contractor shall notify the Contracting Officer at least 15 days prior to the shipment of any treated ties or timbers from the manufacturer's plant, to provide the Government the opportunity to inspect the materials before shipment. When inspections of onsite materials result in product rejection, the Contractor shall promptly segregate and remove rejected material from the premises. The Government may also charge the Contractor any additional cost of inspection or test when prior rejection makes reinspection or retesting necessary.

2.9.1 Crossties

Wood crossties shall conform to Chapter 3, Part 1 of AREA-01.

Wood crossties: Wood ties shall be sawed and shall be not less than 178mm thick and 229 mm wide. The length shall be 2.6 m.

2.9.2 Switch Ties

Switch ties shall conform to Chapter 3, Part 2 of AREA-01 and shall be sawed 178 mm thick and 229 mm wide. The length and quantities shall be as shown.

2.9.3 Bridge Ties

The method for treatment of bridge ties shall be in accordance with AWPA C2. The treatment standards shall be based on the type of deck on the bridge. Any drilling of bolt holes shall be performed prior to treatment. The ties shall be sawed to dimensions and furnished in the quantities indicated on the contract drawings. The Contractor shall field verify all dimensions and quantities prior to furnishing timber bridge ties.

2.9.3.1 Ballasted-Deck Bridge Ties

Ties for use in track over ballasted deck bridges shall be standard crossties.

2.9.4 Tie Plugs

Tie plugs shall fit holes from which spikes are drawn. The plugs shall comply with Chapter 3, Part 1 of AREA-01 and shall be treated in accordance with Chapter 3, Part 6 of AREA-01.

2.10 ANTI-SPLITTING DEVICES

Crossties and switch ties shall be equipped with anti-splitting devices of the type specified, regardless of whether or not the wood has shown any tendency to split. Products used shall conform to Chapter 3, Part 1 of AREA-01. Anti-splitting devices shall be applied in accordance with Chapter 3, Part 1, Section 10 of AREA-01. Crossties shall be equipped on each end with gang nails (nail end plates). Switch ties shall be equipped with gang nails.

2.11 TURNOUTS

The component parts of the turnouts to be furnished shall be the products of manufacturers regularly engaged in the manufacture of such products, and shall essentially duplicate items that have been in satisfactory use at least 2 years prior to bid opening. The parts need not all be made by the same manufacturer, but each turnout shall be the product of a single firm. Switch assemblies, stands, frogs, and guardrail assemblies shall conform to the requirements of AREA-02.

2.11.1 Rail and Joint Bars

Rail, joint bars, and miscellaneous track materials used in turnout construction shall be furnished and installed as part of the complete turnout. Rail and miscellaneous track materials used in turnout construction shall be the weight and section shown on the contract drawings.

2.11.2 Maximum Wear Used Rails Installed in Turnouts

The average top (vertical) wear shall be 3 mm or less. Gauge side head wear shall not exceed 3 mm.

2.11.3 Frogs, Switches, Guardrails and Appurtenances

Frogs, switches, guardrails and appurtenances shall be new or rebuilt materials suitable for use in heavy tonnage main track. Used turnout materials shall have been fully reconditioned and shall be within plus or minus 3 mm of the original specification for that turnout design. Materials used in the turnout shall be of the same weight and section. Materials shall be in good condition and free from excessive rust, dirt, and other foreign materials. The rail weight and section shall be as specified.

2.11.3.1 Switches

Switches for new turnout construction or complete turnout replacement shall be 5030 mm reinforced straight split switches with graduated risers generally conforming to AREA-02 Plan Number 112. Switch materials used to replace defective materials shall be as indicated.

a. Switch points shall be new. Switch point detail shall be AREA-02 Plan No. 221, Detail 4000 or 6100.

b. Switch rods and connecting rods shall be new.

c. Gauge plates, switch plates, slide plates, and heel plates shall either be new or used and in good condition and not worn or corroded. Rail braces shall be either rigid or adjustable. For a given turnout all rail braces shall be of the same design.

d. Heel blocks shall be either cast or forged steel and be either new or used and in good condition. New heel block bolt assemblies shall be provided and shall be heat treated. The heel joint bars shall be either new or used in good condition and manufactured for the purpose.

2.11.3.2 Frogs

Frogs shall be railbound manganese, as shown in AREA Plan 600, or solid manganese self-guarded, as shown in AREA Plans 641 and 691 (Section B-B), in the sizes indicated. Self-guarded frogs shall not be used in turnouts on the Bypass track or the Connector track.

a. Frogs shall be new or remanufactured. Cracked or broken used frog castings shall not be used. Cracked or broken frog castings that have been repaired by welding are not acceptable and shall not be used. Remanufactured frogs shall meet the following wear requirements:

(1) Frog points shall be in good condition and not be worn, chipped, or broken.

(2) Maximum allowable wear on used or reconditioned frogs shall be:

Frog Point:	3 mm
Top Surface:	3 mm
Raised Guarding Face (Self-Guarded)	3 mm
All Wear Surfaces	3 mm

(3) Minimum flangeway depth for used frogs shall be 45 mm. Minimum flangeway width shall be 48 mm.

b. Frog bolts, nuts, lock washers, and headlocks shall all be new.

2.11.3.3 New or Replacement Guard Rails

New or replacement guard rails shall be a minimum of 4.6 m in length and shall be new or used in good condition. Guard rails shall be of any of the following designs: Tee rail per AREA-02 Plan No. 504, solid manganese steel per AREA-02 Plan No. 510, or an acceptable hook flange design. For used guard rails the guard face shall be smooth and not worn more than 3 mm from its new condition. Guard rails bolted to the running rails shall be equipped with fillers. When fillers are installed or repaired new bolt assemblies shall be used. All bolts, nuts, and associated hardware shall be new. Clamped guard rails shall be equipped with block wedges, filler wedges, and cotter keys. Guard rail plates shall be new or acceptable replacements. Single-shoulder tie plates used with guard rails shall be installed with the shoulder on the inside flush against the base of the guard rail.

2.11.3.4 Hook Plates

Hook plates shall be new or acceptable used material and shall be of the

designs and lengths indicated on AREA-02 Plan Nos. 112 and 241.

2.11.3.5 Switch Stands

a. New switch stands shall conform to AREA-02Plan 251-64 and shall be new or fully reconditioned, low-stand type. Switch stands shall be positive-action (rigid) with adjustment from the top with shims through a movable cover.

b. Each stand shall be equipped with the following switch lamps:

Reflecting Type with Daylight Disk: Approved reflecting switch lamps fitted with standard commercial-type double red and white reflecting lenses, and with day signal targets.

2.11.4 Rail Braces

Rail braces shall be adjustable type and shall be of standard manufacture.

2.12 GRADE CROSSINGS

2.12.1 Crossing Material or Surface

Roadway width shall be as indicated in the contract drawings. Crossing material or surface shall comply with the following:

a. A permanent aggregate crossing shall be constructed of compacted crushed aggregate placed in the track between bond timbers header as indicated. The crushed aggregate shall be Number 5 ballast.

2.12.2 Rail

Rail within the road crossing shall be as specified in paragraph Rail and Joint Bars. Rail joints shall not be located within the crossing or for 6 m on either side of the crossing.

2.12.3 Ties

Ties within the road crossing and for at least 6 m on either side of the crossing shall be hardwood and shall be as specified in paragraphs Crossties and Switch Ties.

2.12.4 Track Materials

Tie plates, spikes or other rail fasteners, rail anchors, and other track materials shall be as specified in paragraph MISCELLANEOUS TRACK MATERIALS.

2.12.5 Threaded Fasteners and Screw Spikes

Threaded fasteners for use in grade crossings shall be of the sizes and lengths specified by the grade crossing manufacturer or as indicated for built-in-place crossings. Screw spikes shall have a minimum ultimate tensile strength of 414 MPa and shall be galvanized for corrosion protection.

2.12.6 Pipe for Subdrains

Pipe for subdrains shall be 152 mm (6 in.) diameter corrugated, perforated polyethylene complying with ASTM F 405 or bituminous coated galvanized corrugated steel.

2.12.7 Cable Conduit

Cable conduit under grade crossings shall be PVC pipe conforming to ASTM F 512, size as indicated, and shall be a minimum of Schedule 80.

2.13 MISCELLANEOUS TRACK MATERIALS

Miscellaneous track materials shall be as follows:

2.13.1 Spikes

2.13.1.1 Track Spikes

Track spikes shall be new and shall conform to Chapter 5, Part 2 of AREA-01. Track spikes size 152 by 16 mm shall be used with 57 kg/m (115 lbs) or heavier rail.

2.13.2 Bolts, Nuts, and Spring Washers

New track bolts, nuts, and spring washers shall be used throughout the project for both new and relay rail. Bolts shall be used in both steel and timber bridge connections.

2.13.2.1 Bolts and Nuts

The various rail, joint bars, and rail drillings require various lengths and diameters of bolt assemblies. The Contractor shall determine the number of bolt assemblies of each size required. All bolt diameters shall be the largest possible for a given rail drilling and joint bar punching. Bolts shall be the proper length for the joint bar to allow at least one full bolt thread to extend past the outside of the nut. Track bolts and nuts shall conform to Chapter 4, Part 2 of AREA-01. Track bolts shall be long enough to leave at least two threads exposed after the nut is tightened. Steel bridge connections shall use ASTM A 325M or ASTM A 490M bolts. Timber bridge connections shall use hot dip galvanized steel bolts, minimum 19 mm diameter with lengths as required.

2.13.2.2 Spring Washers

Spring washers and nuts shall be sized to ensure that the spring washer develops its full reactive force and does not jam into the joint bar hole.

Spring washers shall be of the size to fit the bolt and nut used and shall conform to Chapter 4, Part 2 of AREA-01, and Section M12 of AREA-02.

2.13.3 Rail Anchors

Where special tools are required to install or remove anchors, the Contractor shall furnish a minimum of one tool for each 5,000 anchors, or fraction thereof, not to exceed 5 tools per job.

2.13.3.1 New Installation

Rail anchors for new installations shall be new. Sizes shall conform to the various sizes of rail on the project and conform to "Specifications for Rail Anchors" in Chapter 5, Part 7 of AREA-01. Anchors may be either drive-on or spring type.

2.13.4 Insulated Joints

Insulated joints shall conform to applicable portions of AREA-01. Conventional continuous insulated joints with fibre insulation shall not be used. Unless otherwise directed by the Contracting Officer, insulated joints shall be for the rail sections and rail drilling as specified in paragraph RAIL AND JOINT BARS.Location of joints shall be as shown on the contract drawings.

2.13.5 Bumping Posts and Cushion Heads

Bumping posts and cushion heads shall be new and shall be of a standard design that has been in use by commercial railroad industry for at least 5 years. Bumping posts and cushion heads shall be manufactured by a company regularly engaged in the manufacture of these products.

2.13.5.1 Bumping Posts

Bumping posts shall be of all-steel construction, shall bolt firmly onto the rail, and shall be of a type designed for general service. Bumping posts shall have tension and compression members with a moment of inertia not less than 435×10^4 mm^4 .

2.13.5.2 Cushion Heads

Cushion heads shall be of all steel construction, shall firmly bolt, attach, or clamp onto the bumper. Cushion heads shall resist 36,240 kg (80,000 lbs) of compression.

2.13.6 Used Bumping Posts

Used bumping posts shall not be furnished by the Contractor. New fastening materials shall be used to install or reinstall used bumping posts. The Contractor shall furnish new fastening materials conforming to the applicable sections of this specification and AREA-01 and AREA-02.

2.13.7 Inner Guard Rail

Inner guard rail shall be Class IV or better used rails as indicated in Part 2, Chapter 4, "Inspection Classification of Second Hand Rail for Welding", of AREA-01. Rail shall be 36.2 kg (80 lbs) or greater. All

rails used at any one inner guard rail location shall be the same weight and section. Joint bars shall match the rail provided and shall be in good condition.

2.13.8 Gauge Rods

2.13.8.1 New Gauge Rods

New gauge rods shall be the double-clamp style manufactured in conformance with "Specifications for Special Trackwork" of AREA-01. The double clamp style gauge rods shall be threaded on both ends and shall be equipped with four malleable steel casting clamps to rigidly hold both sides of the base of both rails.

2.13.8.2 Used Gauge Rods

Used gauge rods shall not be furnished by the Contractor.

2.14 SALVAGED MATERIALS

2.14.1 Dunnage

Pallets, sills, and other material used for packaging and stacking salvaged track items shall be clean, free of decay or other defect, and sufficiently sturdy for the service intended.

2.14.2 Marking Paint

Marking paint shall be a good quality oil-based spray marking paint or a good quality oil-based paint marker.

2.14.3 Salvaging Rail

The Contractor shall salvage rail as directed; the Government will make available salvaged rail to the Contractor subject to the following:

a. Nondefective and reclaimable rails salvaged from existing tracks may be used to execute new track work at other locations of the project, subject to review and approval of the materials by the Contracting Officer.

b. Reclaimable defective rails may be used to construct inner guard rails provided all defects can be cropped off. Detailed inspection shall be made of such rails to ensure that rails which contain critical defects such as transverse defects, head-web separations, vertical split heads, pipe, split webs, etc., are not incorporated in the work.

2.14.4 Joint Bars

Nondefective joint bars salvaged from existing tracks may be used to execute new track work at other locations of the project, subject to review and approval of the material by the Contracting Officer.

2.14.5 Tie Plates

Tie plates salvaged from existing tracks, which are not either broken, cracked, or severely corroded or worn, may be used to execute the work subject to review and approval of the material by the Contracting Officer.

2.15 RAIL BONDING AND GROUNDING

2.15.1 Rail Bonds

Rail bonds shall be exothermic type ("Cadweld") bonds applied to the field side of the rail head. For static electricity bonding, bond cables shall be flexible bare copper stranded cables with preformed ends and shall conform to applicable requirements of AREA-01.

2.15.2 Grounding Rods

Grounding rods shall be 19 mm diameter copper clad steel rods or 25 mm diameter zinc-coated steel rods. The minimum length of ground rods shall be 2.5 m.

2.15.3 Ground Connection Cables

Connections between the grounding system or ground rods and rails shall be made with a bare flexible copper stranded 2/0 AWG cable.

2.15.4 Electrical Connecting Hardware

Electrical connecting hardware shall be bronze pressure bar type materials having no rotating parts coming in direct contact with conductors.

2.16 WELDING

2.16.1 Rail Welding Kits

Kits for thermite type rail welds shall be approved by the Contracting Officer before use.

2.16.2 Rail

Rail for welding includes Contractor furnished material. The Contractor shall provide welding kits for all rail sections used.

PART 3 EXECUTION

3.1 REMOVAL, SALVAGE, AND DISPOSITION OF MATERIALS

Tracks and segments of track shall not be dismantled until approved to do by the Contracting Officer. The following materials shall be salvaged by the Contractor for later use by the Government. Some of these items will be used in the construction of new track.

3.1.1 Materials To Be Salvaged

Materials to be salvaged for later use by the Government are:

a. All 115 RE and greater rail.

b. All 115 RE and greater joint bars.

c. All 115 RE and greater tie plates.

Other materials shall become the property of the Contractor and shall be removed from the project.

3.1.2 Methods and Procedures

The Contractor may use any methods to dismantle the track, provided proper measures are taken to ensure the safety of the laborers and the general public, and no damage is caused to track components to be salvaged or other tracks and structures which are indicated to remain. Methods of removal of existing tracks shall not cause damage to adjacent sidewalks or paved roadways. Damage to these facilities caused by the Contractor shall be restored at Contractor's expense.

3.1.3 Inventory of Track Materials

The Contractor shall keep a detailed inventory of excess and salvaged track materials stockpiled for the Government. Detailed inventory shall be recorded in appropriate format and furnished to the Contracting Officer.

3.1.4 Inspection and Reconditioning of Used Track Materials

Salvaged track materials shall be cleaned and inspected for defects to determine their suitability for further use.

3.1.4.1 Cleaning By Hand or Mechanical Means

Rail, joint bars, tie plates, and other materials shall be cleaned by hand or mechanical means to remove all adhering dirt and heavy rusting so that the bare steel can be examined.

3.1.4.2 Visual Examination of Rails

Rails shall be visually examined for evidence of defects such as those illustrated on AREA Form 402-A found in Section 4-3 of AREA-01. Such defects shall be brought to the attention of the Contracting Officer who will be the final judge as to the serviceability of the rail. Rails having bolt hole cracks or end batter under paragraph TRACK REPAIR that can be reconditioned for use by cropping and redrilling shall be marked at the location of the defect with yellow paint. Rails with other defects or which cannot be reconditioned shall be rejected as scrap and shall be marked with bright red paint and stacked separately.

3.1.4.3 Visual Examination of Joint Bars

Existing joint bars and compromise joint bars which are removed and no longer required at that location due to rail replacement or other work may be cleaned and reused at other locations, subject to review and approval of the Contracting Officer. Joint bars and compromise joints that are not reused shall be salvaged or scrapped. Joint bars shall be visually examined for defects and wear. Joint bars with bolt hole or spike slot cracks shall be scrapped. Bars which do not fit tightly against the rail or bars in which the bolt holes are excessively corroded or worn shall be scrapped. The Contracting Officer will be the final judge of the serviceability of joint bars. Scrapped bars shall be marked with bright red paint and stacked separately.

3.1.4.4 Visual Examination of Tie Plates

Tie plates shall be visually examined for cracks, breaks, excessive wear, and excessive corrosion. Track material with these defects shall be

considered scrap, marked with bright red paint and stacked separately.

3.1.5 Transport and Stack Excess and Salvaged Materials

3.1.5.1 Material Not Used In Track Repair

Excess and salvaged materials which are not used in track repair work shall be stacked at a site on the military installation designated by the Contracting Officer.

3.1.5.2 Stacking of Rails

Rails shall be stacked on approved sills a minimum of 152 mm above the ground. Rails shall be stacked with the heads up and with the ends even. Each layer shall be separated by at least three 50 by 100 mm wood strips evenly spaced along the length of the rail. Rail shall be grouped by weight, section, drilling, condition, length, and amount of wear. The weight, section, drilling, and length shall be marked on one of the rails near the mid-height of the stack. These markings shall be painted neatly near one end of the rail.

3.1.5.3 Stacking of Joint Bars and Tie Plates

Joint bars and tie plates shall be sorted by section, punching and condition and shall be stacked on pallets. Each pallet stack shall be steel banded for forklift handling. The maximum weight on any pallet shall be 679.5 kg (1,500 lbs). Compromise joint bars shall be wired together in pairs and stacked on pallets, separate from other bars.

3.1.5.4 Stacking of Special Trackwork Materials

Special trackwork materials shall be palletized and stacked as directed by the Contracting Officer.

3.1.6 Material to be Scrapped

All material not specified to be salvaged shall be scrapped and shall become the property of the Contractor.

3.2 PLACEMENT OF BALLAST AND SUBBALLAST

Ballast and Subballast shall be placed to the lines and grades indicated. Subbase course shall conform to the requirements of Section 02731SUBBASE COURSES. Subballast shall not be placed on soft, muddy, or frozen areas. Where the prepared subbase course is soft, muddy, rutted, exhibits severe depressions, or is otherwise damaged, the subballast shall not be placed until the damaged subbase course has been repaired and the area has been approved by the Contracting Officer.

3.2.1 Subballast

3.2.1.1 Subballast Placement

Subballast shall be placed in uniform horizontal lifts of not less than 100 mm and no more than 152 mm for the full width of the cross-section to the total depth indicated. Each subballast layer shall be shaped to a section conforming to the subballast section shown on the drawings and shall be thoroughly compacted. [AM #1] One density test per 46 linear

meters shall be performed.

3.2.1.2 Subballast Compaction

Each subballast lift shall be compacted using approved compaction equipment. The roller weights, vibration frequencies (where applicable), tire pressures (where applicable), and number of passes shall be sufficient to obtain in-place densities across the full width of the subballast and throughout the entire depth of the layer of not less than 95 percent of the ASTM D 1557 laboratory maximum dry density for the subballast material. Prior to placement of subsequent subballast layers the top of the previous layer shall be scarified to a depth of approximately 50 mm to insure proper bond of the layers.

3.2.2 Ballast

3.2.2.1 Ballast Placement

Number 5 AREA ballast shall be placed in the tracks where indicated; 100 mm of Number 5 ballast shall be used near turnouts to provide a smooth walking surface for railroad employees. All other areas shall require size AREA Number 4 ballast.

3.2.2.2 Ballast Distribution

Ballast shall not be distributed until the subballast has been approved by the Contracting Officer. No payment will be made for ballast which is distributed without the Contracting Officer's approval.

a. Ballast distribution shall be to the depth indicated and may be from either trucks or railroad cars. A government locomotive is not available for unloading ballast.

b. Forming of ruts that would impair proper roadway drainage shall be prevented when distributing ballast from trucks and off track equipment. Any ruts formed greater than 25 mm shall be leveled and graded to drain.

c. Ballast shall be unloaded as close as possible to the point of use so that unnecessary handling is prevented. Excess ballast shall be picked up and redistributed at the Contractor's expense. If additional ballast is required for dressing, it shall be added by the Contractor at no increase in unit price.

d. Ballast cars shall not be released until they have been inspected. Ballast cars may be weighed by the Government before and after dumping the ballast at no cost to the Contractor.

3.2.2.3 Ballast Below Ties

For new construction, ballast up to 100 mm below the tie may be placed prior to rail and tie installation. The remaining ballast below the tie, the shoulder ballast and the ballast in the tie cribs shall be placed subsequent to the rail and tie installation. For surfacing existing track, the ballast shall be placed subsequent to rail and tie replacements.

3.3 TRACK CONSTRUCTION AND OUT-OF-FACE RELAY

Track construction not covered specifically herein shall be in accordance

with AREA recommendations and recommended practices.

3.3.1 Roadbed Preparation

Clearing and grubbing, grading, excavation, embankment preparation, and subgrade preparation shall be performed in accordance with Sections 02300 EARTHWORK and 02230 CLEARING AND GRUBBING. Roadbed surface, grade, and drainage shall be approved prior to any distribution of construction material. Where the subgrade or roadbed is damaged during distribution of materials, ruts and depressions shall be filled and compacted and the roadbed surface reapproved prior to track construction.

3.3.2 Geotextile for Track Construction

Geotextile shall be installed between the subbase course and the subballast as shown. Installation shall be in accordance with subparagraph Geotextile Installation under paragraph Crossings.

3.3.3 Unloading the Materials

The use of picks in the handling of ties will not be permitted. Rails shall be unloaded from cars with an approved derrick or crane and placed with the head up without dropping and with sufficient support under the base. Rails of proper length shall be distributed as necessary for road crossings, switches, joint spacing, and other special conditions.

3.3.4 Ties

Standard center-to-center spacing of crossties shall be 560mm. Switch ties shall be spaced as indicated on the drawings. Ties shall be laid perpendicular to the center line of the track with the grain up (heartwood side down). The best ties shall be used at the rail joints. The ends of ties on one side of the track shall be parallel to the rail and the center of the tie shall be on the approximate center line of the track. The ends shall be aligned on the inside of curves and shall continue on that side until reaching a curve in the opposite direction. On double tracks, the ties shall be aligned on the outside ends. The top surface of ties shall provide full bearing for the tie plates. Adzing shall be restricted to that necessary to provide a sound true bearing for the tie plate. Adzing in excess of 5 mm will not be permitted. Where adzing is necessary, the cut surface shall be completely saturated with creosote or other approved preservatives.

3.3.5 Tie Plates

Tracks shall be fully tie-plated. Tie plates shall be free of dirt and other foreign material when installed. Tie plates shall be placed so that the rails will have full bearing on the plate, and the plate will have full bearing on the tie. Tie plates shall be set at right angles to the rail with the outside shoulder against the base of the rail, and centered on the tie. Canted tie plates shall be installed to cant the rail inward.

3.3.6 Rail

The base of the rail and the surface of the tie and tie plate shall be free of dirt and other foreign materials prior to laying rail.

3.3.6.1 Laying Rail

Rail shall be laid without bumping or striking, to standard gauge (1.435 m (4 ft 8-1/2 in.) between points 16 mm below the top of the rail) on tangents and on curves up to 12 degrees. For curves 12 degrees and greater, the gauge shall be widened 3.2 mm for each increment of 2 degrees to a maximum of 1.448 m (4 ft 9 in.,) in accordance with TABLE V. The track shall be gauged at every third tie as spikes are being driven.

TABLE V. TRACK GAUGE FOR HIGH DEGREE OF CURVATURE

Degree of Curvature (per 30.5 m (100-ft) chord)		
Equal to or Greater Than (Deg - Min)	But Less Than (Deg - Min)	Track Gauge m (Ft - In.)
0 - 00	12 - 00	1.435 (4 - 8-1/2)
12 - 01	14 - 00	1.438 (4 - 8-5/8)
14 - 01	16 - 00	1.441 (4 - 8-3/4)
16 - 01	18 - 00	1.445 (4 - 8-7/8)
18 - 01	20 - 00	1.448 (4 - 9)

a. Jointed rails shall be laid, one at a time, with space allowance for expansion being provided between rail ends in accordance with TABLE VI.

b. Gaps between rail ends in insulated joints shall only be sufficient to permit insertion of standard end posts.

c. A standard rail thermometer shall be used to determine the rail temperature. The thermometer shall be laid close to the web on the side of the rail base which is shaded from the sun's rays in advance of the laying operation and left there long enough to accurately record the temperature. The contractor quality control representative shall see that rail temperature is checked frequently and that proper rail expansion shims are used. All thermometers shall be calibrated against the Contracting Officer's rail thermometer which will have been accurately calibrated and will be considered as the standard.

d. Except through turnouts and at insulated joints, the staggering of the joints on one side shall not vary more than 460mm in either direction from the center of the opposite rail.

e. Rails less than 10 m in length shall not be used in out-of-face rail relay. However, rails not less than 4 m long may be used for final connections to existing rails to prevent joints from occurring at prohibited locations or to provide the specified joint stagger in curves.

f. Rail joints shall not occur in or within 6 m of a road crossing, alongside of or within 1.5 m of the end of any switch or turnout guard rail.

3.3.6.2 Joints

The joints in opposite rails shall be staggered one-half the rail length but not less than 3.5 m apart, except closer joints may be required at turnouts and insulated joints. Rail less than 4 m in length shall not be installed in track. No joint shall be less than 1 m from switch points.

No joint shall be installed within 6 m of a road crossing, outer perimeter of any structure, or any location which restricts access to the joint. Where joints are required in these areas, the joints shall be welded.

3.3.6.3 Expansion Allowance

Allowance for expansion shall be provided at rail joints by using rail-expansion metal shims. Shims shall be removed to within 12 rails of the laying. Shims shall be of the thickness shown in TABLE VI. The temperature of the rail shall be determined by use of a thermometer placed on the rail base on the side away from the sun. Typical rail gap gauges are as shown.

TABLE VI. SHIM THICKNESS

10.1 m (33 Ft) Rail 99 Joints per km		11.9 m (39-Ft) Rail 84 Joints per km		24.4 m (78-Ft) Rail 42 Joints per km	
Rail Temperature (degrees C)	Shim Thickness (mm)	Rail Temperature (degrees C)	Shim Thickness (mm)	Rail Temperature degrees C)	Shim Thickness (mm)
Below -23	8	Below -14	8	Below 2	8
-23 to -10	6	-14 to -4	6	2 to 8	6
-9 to 1	5	-3 to 7	5	9 to 16	5
2 to 15	3	8 to 18	3	17 to 23	3
over 16	2	over 19	2	over 24	2

3.3.6.4 Cutting Rail

Only rail saws or track chisels shall be used to cut rail. New holes shall be drilled. Holes shall not be burned in rail. Holes cut with a torch will not be accepted. When drilling of rail is necessary, all chips and burrs shall be removed before applying joints.

3.3.6.5 Matching Rails

Where relay rail is used, matching adjacent rails shall not cause lipped or uneven joints. Any mismatched rail ends shall be welded to provide proper match. Rail end mismatch shall not exceed 3 mm on gauge or tread portions of rail.

3.3.6.6 Rail Replacement

The following procedures apply to rail replacement work:

a. Spot rail replacement is defined as replacement of 30 m or less of contiguous rails, usually with rails of the same section. Installation of relief rail in place of defective rail is considered spot rail replacement. Replacement of more than 30 m of contiguous rails shall be considered to be out-of-face rail relay.

b. If spikes are withdrawn, the holes shall be plugged with treated tie plugs of proper size to fit the hole, prior to replacement of rail. If spikes are withdrawn and spikes are to be redriven in existing spike holes, the holes shall be plugged with treated tie plugs prior to redriving the

spike. Tie plugs shall not be installed in prebored holes unless spikes have been driven and withdrawn.

c. All ties shall be spiked with new spikes in accordance with paragraph Spot Tie Replacement.

d. The Contractor shall ensure that rail ends at joints are not lipped or uneven. Tread portion (vertical) or gauge side (horizontal) rail end mismatch shall be no greater than 2 mm. Rail end mismatch greater than 2 mm shall be corrected by welding and grinding on the smaller rail. Grinding the larger rail is not permitted unless approved by the Contracting Officer. Welded transitions shall be made at a rate of 1 to 80.

e. Rails removed from track will be designated by the Contracting Officer as relay (for use on project), reclaimer (to be salvaged and stockpiled), or scrap. Joint bars removed from track will be designated as relay, reclaimer, or scrap. The Contractor shall mark scrap materials as scrap using bright red paint, transport them off the military installation or to the military installation temporary scrapyard. Relay materials required to complete other repair work of this contract shall be transported to the location of need. Reclaimer materials shall be classified and inventoried and stacked at the military installation storage site, all as indicated for salvage materials in paragraph Removal, Salvage, and Disposition of Materials.

f. Metal rail expansion shims shall be used when laying rail. Wood sticks or other material shall not be used as shims. The Contractor shall have a sufficient supply of each shim available to permit rail laying to progress without delay.

3.3.6.7 Out-of-Face Rail Relay

The Contractor shall replace existing rail with the designated new or used rail between designated limits in a continuous operation. It is expected that replacement of one rail of a given track will be completed prior to replacement of the opposite rail. Used rail shall be laid with previous gauge side wear facing out, unless required to match existing wear patterns.

3.3.6.8 Spot Rail Replacement

Spot rail replacements shall be made where necessary to replace existing defective rails or to compensate for rail joint gap adjustments.

a. Replacement Rail: Replacement rail shall be of equal length or longer than the rail it replaces. The minimum length of rail used shall be 4 m (13 ft.) .

b. Spot Rail Replacement Resulting in Joint Staggers: Unless otherwise approved by the Contracting Officer on a case by case basis, spot rail replacement shall not result in joint staggers less than 1.33 m.

3.3.7 Joint Bars

Joint bars shall be clean, and the contact surfaces coated with petrolatum or petrolatum base compound with a corrosion inhibitor. Rail joints shall be installed so that bars are not cocked between the base and head of the rail. Bars shall be properly seated in the rail and the full number of correct-size bolts, nuts, and spring washers installed. Bolts shall be

placed with nuts alternately on inside and outside of rail. A corrosion resistant lubricant shall be applied to the bolt threads prior to application of nuts. Bolts shall be tightened to torque of approximately 476 N m for 25 mm diameter bolts and 544 N m for 29 mm diameter bolts, beginning at the center of the joint and working both ways to the ends of the joint. After the track has been in service, but before acceptance of the work, all bolts shall be checked and retightened to a torque of approximately 476 N m for 25 mm diameter bolts and 544 N m for 29 mm diameter bolts Rail of different sections shall be connected by properly fitting compromise joint bars. The mismatch for compromise joints for either tread surface or on the gauge side shall not exceed 3 mm. Defective joint bars , discovered by the Contractor during track repair operations, or as identified by the Contracting Officer shall be replaced with acceptable joint bars.

3.3.8 Spiking

3.3.8.1 Spiking Procedures

Rail shall be spiked promptly after being laid. Spikes shall be started and driven vertically and square with the rail. Spikes shall be driven to allow approximately 3 to 5 mm space between the underside of the spike and the top of the rail base. Spikes shall not be overdriven, or straightened while being driven. Spikes shall not be installed through the slots in skirted-type, slotted joint bars (angle bars). Spikes shall not be driven against the ends of joint bars.

3.3.8.2 Number of Spikes

Four rail-holding spikes shall be used on each tie on tangents and curves less than 4 degrees. Spikes on the gauge side of the running rail shall be placed directly across from each other and the spikes on the field side of the running rail shall be placed directly across from each other. This pattern shall be held consistent. On curves 4 degrees or greater but not more than 8 degrees, six spikes shall be used on each tie with the spikes located as follows: High rail, one rail-holding spike and one plate holding spike on the field side and one on the gauge side; Low rail, one rail-holding spike on the gauge side, one rail-holding spike on the field side, and one plate-holding spike on the field side. Curves 8 degrees and greater shall be spiked with eight spikes per tie, located as follows: High rail, one rail-holding spike and one plate-holding spike on the field side and two rail-holding spikes on the gauge side; Low rail, one rail-holding and one plate-holding spike on both the gauge and field sides. Eight rail-holding spikes shall be used on each tie through road crossings.

3.3.9 Tie Plugs

If spikes are withdrawn, the holes shall be swabbed with creosote and plugged with creosoted tie plugs of proper size to fit the hole. If spikes are withdrawn and spikes are to be reinserted in existing spike holes, the holes shall be swabbed with creosote and plugged with creosoted tie plugs prior to redriving the spike. Tie plugs shall not be installed in prebored holes unless spikes have been driven and withdrawn.

3.3.10 Rail Anchor Placement

Rail anchors shall be located as indicated on the project plans. Where the use of rail anchors is indicated, apply anchors per 11.9 m of rail in the

number and pattern indicated on the project drawings. The rail anchors shall be spaced approximately uniformly along the rail length. Rail anchors shall be installed to the gauge side of the rail against the same tie face on opposite rails. Rail anchors shall grip the base of the rail firmly and shall have full bearing against the face of the tie. Rail anchors shall not be moved by driving them along the rail. Rail shall be anchored immediately after spiking and before rail has experienced a large temperature change.

3.3.11 Inner Guard Rails

Guard rails shall be installed on bridges and trestles as indicated. Guard rails shall be approximately 280 mm from the gauge side of track rails and shall extend a minimum of 15 m beyond the structure. The ends shall be curved inward and beveled. Guard rails shall be fully bolted. Guard rails shall not be higher than the running rail and shall not be more than 25 mm lower than the running rail. Each guard rail shall be spiked with two spikes to each tie but shall not be tie-plated. Unfit track rail in short lengths may be used for guardrails.

3.3.12 Turnouts

Turnouts shall be located as indicated on the drawings. Switch, frog and guardrail assemblies shall be complete. Stock rails shall be accurately bent. Changes in rail weight or section will not be permitted within the limits of the switch ties. Headblocks shall be at right angles to the main track and shall be securely spiked in place. Except where directed otherwise, switch stands shall be installed so that when the switch is set for the normal position, the connecting rod keeps the points closed with a pulling force. Switches shall be properly adjusted. Switch components and slide plates shall be lubricated.

3.3.13 Not Used

3.3.14 Superelevation

Curves located on the Connector track having a radius of 500 meters or less shall be superelevated unless otherwise directed by the Contracting Officer. Superelevation shall be obtained by raising the outside rail of the curve. The inside rail shall be maintained at grade. The maximum superelevation will be 15 mm. Full superelevation shall be carried throughout each curve, unless otherwise directed. Superelevation runoff shall be at a uniform rate, and shall be applied on the tangents at the beginning and end of a curve. The normal rate of superelevation runoff will be 13 mm in 9.4 m (1/2 in. in 31 ft).

3.3.15 Preliminary Surfacing

The preliminary alignment and surfacing gangs shall follow the unloading of the ballast. Rail renewal, tie renewal, bolt tightening, and ballast placement shall be complete prior to commencement of surfacing and alignment work.

3.3.15.1 Lifts

a. The track, after being aligned, shall be brought to grade and

surface in lifts not exceeding 100 mm each. After each lift, the ballast shall be tamped. When using jacks, they shall be placed close enough together to prevent undue bending of rail or stress of rail and joint. Both rails shall be raised at one time and as uniformly as possible, except where superelevation is required. The track shall be so lifted that after a period of not less that 5 train operations (70 metric ton ballast car) after the last lift, it will be necessary to give the track a final lift of between 25 and 50 mm to bring it to grade.

b. In areas where major track resurfacing is not required, the Contractor shall perform a "skim lift" tamping operation to ensure that the ties are adequately tamped, the ballast section is adequately compacted and dressed, and to correct minor deficiencies in surface and alignment. The rise in skim lift areas shall be 25 mm or less and usually will not require that additional ballast be placed.

c. A 50 mm rise shall provide an average 50 mm raise in the track being surfaced.

d. A 100 mm rise shall provide an average 100 mm raise in the track being surfaced, and shall be made in at least two lifts not to exceed 50 mm per lift.

e. A 150 mm raise shall provide an average 150 mm raise in the track being surfaced, and shall be made in at least 2 lifts. The initial lift shall not exceed 100 mm with the final lift not to exceed 70 mm.

3.3.15.2 Tamping

Raising and tamping of track shall be performed with an automatic, vibratory, squeeze type power tamper with 16 tamping heads, capable of raising both rails simultaneously and maintaining cross-level. The equipment to be used for surfacing operations is subject to approval by the Contracting Officer. Every tie in the track shall receive two or more full insertions of the tamping heads. Ballast shall be power-tamped under both sides of ties from each end to a point 380 mm inside each rail for 2.6 m ties. The center shall be filled with ballast, but tamping will not be permitted in the center of the tie between the above stated limits. Both ends of the ties shall be tamped simultaneously and tamping inside and outside of the rail shall be done at the same time. Tamping tools shall be worked opposite each other on the same tie. Ballast under switch ties and road crossing ties shall be tamped the entire length of each tie. All ties shall be tamped to provide solid bearing against the base of the rail after the track or turnout is raised to grade at final surfacing. All down ties shall be brought up to the base of rail and shall be machine tamped. The resultant track surface and alignment shall be uniform and smooth. Tamping of track in snow or frozen ballast conditions will not be permitted.

3.3.15.3 Not Used

3.3.15.4 Runoff of Track Raises

The runoff at the end of a rise shall not exceed 13 mm in 9.4 m (1/2 in. in 31 ft) of track unless otherwise approved by the Contracting Officer.

3.3.15.5 Horizontal Realignment

Horizontal realignment of curved track shall be established by the Contractor using manual or mechanical means as described in the AREA-01 Chapter 5, Part 3 article titled, "String Lining of Curves by the Chord Method".

3.3.16 Final Surfacing

After preliminary surfacing has been completed, grade and line stakes shall be checked and the track brought to grade and alignment.

3.3.16.1 Final Tamping

Track shall be brought to grade and the ballast retamped in the manner described for preliminary surfacing, except that the tamping distance inside the rail shall be decreased from 380 to 330 mm for 2.6 ties.

3.3.16.2 Final Alignment

The track shall be given a final aligning conforming to the established track centers.

3.3.16.3 Final Dressing

After the final alignment the ballast shall be dressed to the section indicated. After final dressing ballast shall not cover the tops of the ties. The portion of the subgrade outside the ballast line shall be left with a full, even surface and the shoulder of the subgrade shall be properly dressed to the indicated section to provide proper drainage away from the track.

3.3.16.4 Surplus Ballast

Surplus ballast remaining after final surfacing and dressing of the ballast section shall be distributed or otherwise disposed of as directed by the Contracting Officer.

3.3.17 Cleanup

Upon completion of the work, the Contractor shall remove all rubbish, waste, and discarded materials generated by the work from the project area . Areas where the Contractor has worked, including but not limited to, project areas, material storage sites, and borrow or disposal areas shall be left in a clean, well-graded, and well-drained condition.

3.3.17.1 Shoulder Removal and Reconstruction

Where track construction operations result in deposition of materials along the track shoulders that would impede the free drainage of the geotextile and track structure, the Contractor shall remove the material.

3.3.17.2 Spoil Materials

Spoil materials removed from the track shall be disposed of off site at the Contractor's expense. Spoil materials shall not be placed on the shoulders, in ditches, in drains, or in other areas where they would impede the flow of water away from the track.

3.3.18 Final Adjustments

Sixty calendar days after the track has been accepted and put into operation, the Contractor shall perform, at no cost to the Government, necessary resurfacing adjustments to leave the track in alignment and on grade.

3.3.19 Tolerances for Finished Track

Completed track shall meet the following tolerances. Track not meeting the tolerances specified below shall be repaired to meet these requirements, at no additional cost to the Government.

3.3.19.1 Gauge

Track gauge shall be within plus 6 mm (1/4 in.) or minus 3 mm (1/8 in.) of standard gauge.

3.3.19.2 Alignment

Alignment shall be measured as the deviation of the mid-offset of a 18.9 m line, with the ends of the line at points on the gauge side of the line rail, 16 mm (5/8 in.) below the top of the railhead. Either rail may be used as the line rail on tangent track; however, the same rail shall be used for the entire length of the tangent. The outside rail in a curve is always the line rail. Alignment on tangents shall not deviate from uniformity more than 13 mm Alignment on curves shall not deviate from uniformity more than 10 mm (3/8 in.).

3.3.19.3 Track Surface

Track surface shall meet the following requirements:

a. The runoff at the end of a raise shall not exceed 13 mm in any 9.4 m of rail.

b. The deviation from design profile on either rail at the mid-ordinate of a 18.9 m chord shall not exceed 13 mm.

c. Deviation from zero cross level at any point on tangent or from designated superelevation on curves shall not exceed 13 mm.

d. The difference in cross level between any two points less than 18.9 m apart on tangents, shall not exceed 13 mm.

3.3.19.4 Guard Face Gauge

Guard face gauge is the distance between the guard lines measured across the track at right angles to the gauge line, and is measured at the point of frog on both sides of the turnout. The design value for guard face gauge is 1340 mm (52-3/4 in.). Guard face gauge shall be within plus or minus 3 mm (1/8 in.) of the design value.

3.3.19.5 Guard Check Gauge

Guard check gauge is the distance between the gauge line of a frog and the guard line of its guard rail, or guarding face, measured across the track at right angles to the gauge line. The design value for guard check gauge

is 1388 mm (54-5/8 in.). Guard check gauge shall be within plus or minus 3 mm (1/8 in.) of the design value.

3.4 ROAD CROSSINGS

Crossings within the project shall be constructed as indicated on the contract drawings.

3.4.1 Subgrade

For new construction, the subgrade in the crossing area and for 6 m beyond each end of the crossing shall be bladed to a level surface and compacted to at least 90 percent CE55 maximum dry density for cohesive materials or 95 percent CE55 maximum dry density for cohesionless materials. Drainage areas shall be cleaned and sloped away from the crossing in both directions along the track and the roadway.

3.4.2 Geotextile Installation

Geotextile shall be placed between the subbase and the subballast section.

3.4.2.1 Preparation

Surfaces on which geotextiles will be placed shall be prepared in accordance with the applicable portions of this specification and shall be free of irregularities such as sags, cavings, erosion, or vegetation. Any irregularities shall be corrected to ensure continuous, intimate contact of the geotextile with the whole surface. Any loose material or debris shall be removed prior to geotextile placement.

3.4.2.2 Placement

a. The geotextile shall be carefully placed on the prepared surface with the long dimension parallel to the prepared surface. The geotextile shall be placed free of wrinkles, folds, creases, and tension. The geotextile shall be held in place by pins, small aggregate piles, or ballast bags, until it is completely covered. The geotextile shall be covered immediately after placement in track. The maximum exposure time for the geotextile, from removal of the protective shipping cover to placement of the subballast cover materials which prevent exposure to sunlight, shall be 2 consecutive days.

b. The minimum overlap of geotextile rollsshall be 900 mm. If several geotextile units are placed with the required overlap prior to the placement of the subballast, the overlap distance of each overlap shall be checked as placement of subballast approaches the overlap. The Contractor shall ensure that the required overlap exists when the geotextile is covered.

c. The geotextile shall remain free of any contamination such as mud, dust, sediment, debris, etc., that will impair its function. Contamination shall be removed without damage to the geotextile or to the prepared surface at the Contractor's expense. If the geotextile is damaged, its function impaired by the cleaning efforts, or if it cannot be properly cleaned, the Contractor shall repair the prepared surface, if necessary, and replace the damaged or impaired geotextile with geotextile meeting requirements of this specification. Equipment shall not operate in direct

contact with the geotextile. Surface drainage, as much as possible, shall be directed away from the geotextile installation area to prevent accumulation of mud, debris, and sediment.

3.4.2.3 Placement of Cover Material

Placement of subballast cover material in contact with the geotextile shall be performed ensuring intimate contact of the geotextile with the prepared surface and with the cover material. The placement shall be performed without damage to the geotextile including tears, punctures, or abrasion.

3.4.2.4 Equipment Operations on the Cover Material

A minimum depth of 178 mm of cover material shall be placed over the geotextile before equipment is allowed to operate on the covered geotextile. Equipment operations on the covered geotextile shall be limited to those necessary for track construction and equipment turning will not be allowed on the covered geotextile.

3.4.2.5 Minimum Ballast Depth

The minimum depth of ballast between the bottom of the tie and the top of the geotextile shall be as indicated.

3.4.2.6 Tamping Operations

Tamping of ballast materials shall be performed by setting the tamping force and insertion depth to the minimum necessary to adequately tamp the track. The tamper operator shall monitor the depth of tamping and limit the depth to prevent detrimental effects of the tamper feet on the geotextile.

3.4.2.7 Double Layers

Double layers of geotextile will not be allowed, except for splicing overlaps at seams.

3.4.3 Ballast Placement and Surfacing

Ballast shall be placed and tamped as specified in paragraph TRACK CONSTRUCTION AND OUT-OF-FACE RELAY except that in crossings, the ballast between the ties shall be thoroughly compacted with a vibratory compactor, or other approved means, after each raise. The ballast shall be tamped for the entire length of the crossties for road crossings. The track shall receive final alignment and surfacing prior to placement of the crossing surface. Final surfacing shall bring the track to the final grade and alignment as indicated on the contract drawings. Where the crossing involves two or more tracks, the top of the rail for all tracks shall form a plane with the adjacent roadway surface. The top of rail elevation shall be 50 to 100 mm above surrounding pavement elevation, with a smooth transition of pavement. The ballast in the cribs and on the shoulders shall be compacted using a vibratory plate compactor or other approved means.

3.4.4 Ties

Hardwood ties shall be used. Spacing shall be a minimum of 500 mm center to center. For premanufactured grade crossings, ties shall conform to the

manufacturer's recommendations for the type of grade crossing surface materials being used.

3.4.5 Tie Plates, Spikes, and Anchors

All ties within the crossing and for 6 m beyond each end of the crossing shall be fully tie plated, and spiked with 4 rail-holding spikes per tie plate.

3.4.6 Rail

Rail within the crossing area and for 6 m beyond each end of the crossing shall be, at a minimum, 57 kg/m. Rail shall not be protected from corrosion by application of an approved rust inhibitor. Bolted joints will not be permitted in the crossing or within 6 m of either edge of the crossing surface. Bolted joints will be eliminated by either field welding the joints to form continuous rail throughout this area or by using 24.4 m rail lengths.

3.4.7 Lining and Surfacing

Rail shall be spiked to line and the track mechanically tamped and surfaced to the grade and alignment of the existing track and roadway. Where the crossing involves two or more tracks, the top of rails for all tracks shall be brought to the same plane.

3.4.8 Crossing Surface

The surface of the crossing shall be not greater than 6 mm (1/4 in.) higher than the top of the rails for a distance of 600 mm outside of the rails for either single or multiple-track crossings. A smooth transition shall be made between the crossing surface and the adjoining pavement or material.

3.4.8.1 Type 1A Crossings

The bond timber headers shall be installed with the edge of the timber solid against the edges of the tie plates prior to placement of the aggregate. Headers shall fasten to the ties as indicated using the appropriate size and length fasteners. After installation of the bond timber, the aggregate shall be placed in the track and on the outside approaches and compacted.

3.4.9 Not Used

3.4.10 Crossing Flangeways

Upon completion of the grade crossing installation, the flangeways through the crossing shall be a minimum of 50 mm deep and between 65 and 75 mm wide. The Contractor shall ensure that adequate flangeways are provided prior to installation of the final crossing surface.

3.4.10.1 Flangeway Filler

Except for Type IA crossings all open crossing flangeways shall be filled with asphaltic concrete and compacted as indicated on the drawings.

3.4.10.2 Clean Grade Crossing Flangeways

Where grade crossing flangeways are obstructed (filled in), the Contractor shall remove foreign material to provide a minimum 50 mm depth and 65 mm width flangeways on the gauge side of the rails.

3.5 BONDING AND GROUNDING TRACK

Track shall be bonded and grounded as indicated. Where track is designated for bonding and grounding, the rails shall be bonded electrically continuous and effectively grounded. Connections shall be made by thermite welds or cadwelds in accordance with the manufacturer's instructions.

3.5.1 Rail Joint Bond

Rail joints on both rails of designated track shall be bonded as shown. The bond shall be applied to the field side of the rail web unless otherwise approved by the Contracting Officer. Track to be bonded and grounded shall be electrically insulated from the remaining track using one of the specified insulated joints.

3.5.2 Rail Cross-Bond and Ground

Rail cross-bond and ground shall be installed as indicated. The cross-bond shall be applied to the rail web. One cross-bond and ground shall be installed at 30.5 m intervals along the designated tracks. Connections between grounding system or ground rods and rails shall be made with bare stranded copper cable, installed at least 300 mm below the bottom of the ties. Ground rods shall be driven vertically full-length. The top of the ground rod shall be located at the toe of the ballast slope and shall be a minimum of 300 mm below the top of the subgrade. Maximum resistance to ground from any grounded rail or structure shall not exceed 25 ohms. The Contractor shall make any corrections needed to reduce the resistance to below 25 ohms at no cost to the Government.

3.5.3 Inspection of Rail Bond and Ground

Loose, damaged, or missing rail bond wires, cross bond wires, ground connections, and ground rods shall be visually inspected. If there is a signal failure, bonding can be tested for current loss in the joints using a volt meter. Defective items shall be marked for repair.

3.5.4 Existing Bonds

The Contractor shall protect existing rail bonds, cross-bonds, ground connections, and grounding rods from damage. Except for bonds attached to rails which are designated to be replaced in this contract, replacement of bonds damaged or destroyed by the Contractor's operation shall be replaced at no cost to the Government.

3.5.5 Removal of Defective Bonds

Rail head pin-type and welded-type bonds shall be removed by shear cutting old cables immediately adjacent to the weld or pin. Rail web type pin bonds shall be removed by knocking the old pin out with a drift. Flames or torches shall not be used to remove defective bonds.

3.6 INSTALLATION OF MISCELLANEOUS TRACK MATERIALS

3.6.1 Tie Plates

Tie plates shall be furnished to the work sites as required. Excess tie plates, remaining at the conclusion of the contract, shall be delivered to the military installation storage site and stacked where directed by the Contracting Officer.

3.6.2 Rail Anchors

Rail anchors shall be delivered to the work sites as required. Installation shall be in accordance with paragraph TRACK REPAIR. Excess rail anchors shall be delivered to the designated military installation storage site and stored in approved containers.

3.6.3 Insulated Joints

Insulated joints shall be installed where indicated and in accordance with the manufacturer's installation instructions.

3.6.4 Bumping Posts and Cushion Heads

Bumping posts and cushion heads shall be installed where indicated. Installation shall be in accordance with the manufacturer's instructions.

3.6.5 Inner Guard Rails

Inner guard rails shall be installed as detailed in the contract drawings. Each rail shall be spiked to alternate crossties throughout the full length using two spikes per rail per tie; tie plates are not required. Guard rails shall be installed using acceptable joint bars of the proper size to fit the rails being joined. Each joint shall be bolted with at least two bolts and one fully tightened bolt per rail.

3.6.6 Gauge Rods

3.6.6.1 Rods Per Rail Length

Three gauge rods shall be installed per rail length on all curved track with greater than 10 degrees curvature.

3.6.6.2 Installation of Rods in The Crib and Closure Rail

One gauge rod shall be installed in the crib immediately ahead of the switch point of all turnouts. Two gauge rods shall be installed on the curved closure rail, one ahead of the joint, and one ahead of the toe of the frog in all turnouts.

3.6.7 Installation of Joint Bars

Joint bars shall be installed with their full number of bolt assemblies unless otherwise noted. Bars shall be properly seated on the rail and the bolts tightened beginning at the center of the joint and working toward the ends of the bars, alternating between rails. Bolts used shall be of the proper diameter and length for the rail and joint bars at the joint. The use of extra washers to shim out track bolt nuts is prohibited. Bolts with nuts shall be placed alternately on inside and outside of rail.

3.7 Not Used

3.8 THERMITE WELDING PROCEDURES

Thermite welding procedures shall comply with the following paragraphs:

3.8.1 End Preparation

Rails to be welded shall meet the requirements of Paragraph 1, "Specifications for Fabrication of Continuous Welded Rail" given in Chapter 4, Part 2 of AREA-01. The rail ends shall be aligned in accordance with paragraph GAP AND ALIGNMENT. Rail ends shall show no steel defects, dents, or porosity before welding. Bolt holes shall not be made in, or permitted to remain in, the ends of the rail to be welded. One handling hole may be made in each end of welded string. Rail ends containing such holes shall be cut off during track construction. Rail which must be cut for any reason shall be cut square and clean by means of approved rail saws or abrasive cutting wheels in accordance with Chapter 5 of AREA-01, article, "Recommended Practice For Use of Abrasive Wheels".

3.8.1.1 Cleaning

The rails to be welded shall be cleaned of grease, oil, dirt, loose scale, and moisture to a minimum of 150 mm back from the rail ends, including the railhead surface. Cleaning shall be accomplished by use of a wire brush, to completely remove dirt and loose oxide and by use of oxygen-acetylene torch to remove grease, oil and moisture. A power grinder with an abrasive wheel shall be used to remove scale rust, burrs, lipped metal and mill brands which would interfere with the fit of the mold, for 50 mm on each side of the ends.

3.8.1.2 Gap and Alignment

The minimum and maximum spacing between rail ends shall be as specified by the rail welding kit manufacturer and the approved welding procedures.

a. The ends of the rails to be welded shall be properly gapped and aligned to produce a weld which shall conform to the alignment tolerances below. Alignment of rail shall be done on the head of the rail. The rail gap and alignment shall be held without change during the complete welding cycle.

b. Vertical alignment shall provide for a flat running surface. Any difference of height of the rails shall be in the base.

c. Horizontal alignment shall be done so that any difference in the width of heads of rails shall occur on the field side. Horizontal offsets shall not exceed 1 mm in the head and/or 3 mm in the base.

3.8.2 Surface Misalignment Tolerance

Combined vertical offset and crown camber shall not exceed 3 mm per meter (0.04 in./ft) at 315 degrees C or less. Combined vertical offset and dip camber shall not exceed 1 mm/m (0.01 in./ft) at 315 degrees C or less.

3.8.3 Gauge Misalignment Tolerance

Combined horizontal offset and horizontal kink camber shall not exceed 3 mm/m (0.04 in./ft) at 315 degrees C or less.

3.8.4 Thermite Welding

Welding shall be done in accordance with Chapter 4, Part 2 of AREA-01, articles "Thermite Welding - Rail Joints" and "Specifications for Fabrication of Continuous Welded Rail", except as modified by these specifications. All welds shall be visually inspected at the time of welding.

3.8.4.1 Thermite Weld Preheating

The rail ends shall be preheated prior to welding to a sufficient temperature and for sufficient time as indicated in the approved welding procedures to ensure full fusion of the weld metal to the rail ends without cracking of the rail or weld.

3.8.4.2 Thermite Weld Cooling

The molds shall be left in place after tapping for sufficient time to permit complete solidification of the molten metal and proper slow cooling to prevent cracking and provide a complete weld with proper hardness and ductility.

3.8.5 Weld Finishing and Tolerances

Welded joints in the finished track shall be brought to a true surface and alignment by means of a proper grinding or planing machine (shear). Finish grinding shall be performed with an approved grinder operated by a skilled workman grinding evenly and leaving the joints in a smooth and satisfactory condition. Finishing shall eliminate all cracks. The completed weld shall be finished by mechanically controlled grinding in conformance with the following requirements:

a. A finishing deviation of not more than plus or minus 1 mm (0.01 in.) of the parent section of the rail head surface will be allowed. The gauge side of the rail head shall be finished to plus or minus 1 mm (0.01 in.) of the parent section.

b. Welds produced by welding kits which are specially designed to produce reinforced welds need not be ground in the finishing area except as necessary to remove fins, burrs, cracks, etc.

3.8.6 Weld Quality

Each completed weld shall have full penetration and complete fusion and be entirely free of cracks or fissures. Welds shall meet the acceptance criteria given in AWS D1.1.

3.8.7 Weld Numbering

The Contractor shall semi-permanently mark a sequential weld number on the rail immediately adjacent to the weld, using a quality lead paint marker at the time the weld is made. Welds shall be numbered sequentially in the order in which they are made. The Contracting Officer will provide the Contractor with the initial weld number. Defective welds which are replaced shall be assigned a new sequential number by adding a letter to the defective weld number (e.g., defective weld 347 would be replaced by 347A).

3.9 TRACK REPAIR

3.9.1 Cutting and Drilling of Rail

The Contractor shall use only rail saws and abrasive cutting wheels for this operation. Other methods for cutting rail will not be acceptable. Cuts shall be square and clean. When given the option of cutting existing rail or new rail being installed, the existing rail shall be cut. When new holes are necessary, they shall be drilled. Holes shall not be punched, slotted, or burned with a torch. Holes shall be of the size and located as shown on the contract drawings. Drilled bolt holes shall be peened or ground to remove sharp edges.

3.9.2 Not Used

3.9.3 Spiking

The proper gauge, as indicated in this section, shall be verified immediately prior to spiking.

3.10 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory, or by the Contractor, subject to approval. If the Contractor elects to establish testing facilities, approval of such facilities shall be based on compliance with ASTM D 3740. Work requiring testing will not be permitted until the Contractor's facilities have been inspected and approved. The first inspection of the facilities will be at the expense of the Government and any subsequent inspections required because of failure of the first inspection shall be at the expense of the Contractor. Such costs will be deducted from the total amount due the Contractor.

3.10.1 Ballast and Subballast Samples

Periodic sampling and testing of ballast and subballast material shall be performed to ensure continued compliance with this specification. During construction, one representative sample of the ballast and subballast material shall be taken from each 1818 metric tons (2,000 tons) of ballast and subballast delivered to determine the material gradation. For each 9090 metric tons (10,000 tons) or a fraction thereof of ballast delivered, an additional amount of material shall be obtained in order to perform the quality and soundness tests specified. Samples for material gradation, quality, and soundness tests shall be taken in conformance with ASTM D 75. Test samples shall be reduced from field samples in conformance with ASTM C 702. Sample sizes shall be sufficient to provide the minimum sample sizes required by the designated test procedures. If any individual sample fails to meet the gradation requirement, placement shall be halted and immediate corrective action shall be taken to restore the specified gradation. If any individual sample fails to meet the specified quality and soundness requirements, placement shall be halted and immediate corrective action shall be taken to restore the specified quality.

3.10.2 Ballast and Subballast Tests

3.10.2.1 Sieve Analyses

Sieve analyses shall be made in conformance with ASTM C 117 and ASTM C 136. Sieves shall conform to ASTM E 11.

3.10.2.2 Bulk Specific Gravity and Absorption

Bulk specific gravity and absorption tests shall be made in conformance with ASTM C 127.

3.10.2.3 Percentage of Clay Lumps and Friable Particles

The percentage of clay lumps and friable particles shall be determined in conformance with ASTM C 142.

3.10.2.4 Degradation Resistance

Resistance to degradation of materials shall be determined in conformance with ASTM C 131 and ASTM C 535. Materials with gradations having 100 percent passing the 25 mm sieve, shall be tested in conformance with ASTM C 131. Materials having gradations with particles larger than 25 mm shall be tested in conformance with ASTM C 535.

3.10.2.5 Soundness Test

Soundness tests shall be made in conformance with ASTM C 88.

3.10.2.6 Percentage of Flat or Elongated Particles

The percentage of flat or elongated particles shall be determined in conformance with ASTM D 4791.

3.10.3 Tie Inspection

The Contractor shall be responsible for the quality of the treated ties. Each tie shall be permanently marked or branded by the producer in accordance with AWPA M6. Each treated wood tie shall be inspected, in accordance with AWPA M2, for conformance with the specified AWPA standards. The 100 percent inspection shall be performed by an independent inspection agency approved by the Contracting Officer. Inspection shall be made at the wood treatment site. The agency's report of inspection shall accompany delivery of the ties.

3.10.4 Examination of Geotextile

The Contractor shall sample the geotextile upon delivery to the project site. Sampling procedures used shall be those detailed in ASTM D 4759and ASTM D 4354 with the number of sample units selected from TABLE II of ASTM D 4354. An independent testing laboratory shall perform the index property tests specified in TABLE II on each of the sample units and determine conformance with the minimum requirements of TABLE II. Conformance shall be determined in accordance with ASTM D 4759. Geotextile seams expected to perform a reinforcement function shall be tested in accordance with ASTM D 4595. The Contracting Officer may examine any geotextiles for defects, damage, or nonconformance prior to installation. Any geotextile not meeting the minimum property requirements of paragraph GEOTEXTILE, or geotextile that is determined to be damaged or defective shall be removed from the site and shall be replaced with additional geotextile meeting the requirements of this specification at no additional cost to the Government.

3.11 INSPECTION AND FIELD TESTING

Quality control inspection and field testing shall be performed by the Contractor.

3.11.1 Track

Inspection shall be performed to ensure that all the requirements of these specifications are met. Bolted joints shall be inspected for loose bolts and for smooth transitions between rails of different sections. Rail, tie plates, and ties shall be checked to ensure that the rail is properly seated and has full bearing on the tie plate and tie. Upon completion of construction, measurements of track gauge, cross level, and alignment shall be taken and recorded at least once every 60 m of track centerline length. A copy of these measurements shall be provided to the Contracting Officer.

3.11.2 Welded Joints - Visual Inspection

Each welded joint shall be inspected by the Contractor in the presence of the Contracting Officer after removal of the mold and grinding of excess metal. The Contractor shall pay particular attention to surface cracking, slag inclusion, gas pockets, and lack of fusion. The Contractor shall correct or replace, at no extra cost to the Government, any weld found defective. The method of correction shall be as approved by the Contracting Officer.

3.11.3 Not Used

3.11.4 Thermite Weld Joints Testing

Each thermite weld joint shall be ultrasonically tested following the visual inspection. The method of inspection and acceptance shall be in accordance with AWS D1.1. The Contractor shall correct or replace defective welds, at no additional cost to the Government. The method of correction shall be as approved by the Contracting Officer. Ultrasonic testing shallbe performed by the Contractor after the rail has been installed in track. The testing will determine whether or not each weld meets the criteria of paragraphs Gap and Alignment, Weld Finishing and Tolerances, and Weld Quality. Welds made in the track which the Contracting Officer determines to be unacceptable shall be cut out of the rail and replaced by a section of new rail and two new welds. Saw cuts shall be made at least 150 mm from the centerline of the faulty weld. Replacement welds and replacement rails shall be at the sole expense of the Contractor. Replacement welds shall be renumbered as indicated. Replacement welds made in track shall be ultrasonically tested.

3.11.5 Inspection of Geotextile

At the direction of the Contracting Officer, the Contractor shall remove the cover material from the geotextile at 3 locations per kilometer so that the geotextile may be inspected for damage. At each location, the cover material shall be removed to expose a 1.2 by 1.2 m section of the geotextile. If punctures, tears, improper installation, other impairment or damage are found within this section, additional sections shall be excavated to determine the extent of the damage. Damaged geotextile shall be repaired or replaced and recovered with ballast/subballast at the

Contractor's expense.

3.11.6 Testing Relay Rail

3.11.6.1 Testing for Wear

Each relay rail shall be checked for wear by the Contractor's quality control representative in the presence of the Contracting Officer after the material is delivered to the construction site. The Contractor shall monitor the installation of track for defects in rail and joint bars being installed. Rail and joint bars that are found to be defective shall not be installed in track.

3.11.6.2 Testing for Defects

Upon completion of the track construction, the Contractor shall have the rail tested by ultrasonic methods. Ultrasonic testing shall be done by a contractor normally engaged in this type of testing with a minimum of 5 years of experience. The Contractor shall schedule a rail testing machine and notify the Contracting Officer of the type of machine and schedule. Contractor furnished rails which are found to be defective at that time shall be removed and replaced by the Contractor at no additional cost to the Government. Contractor furnished joint bars and compromise joint bars that are found to be cracked or broken shall be removed and replaced at no additional cost to the Government.

RECORD OF FIELD WELD

INSTALLATION_____ WELD NUMBER _____

FINAL INSTALLED
LOCATION _____ TRACK _____
STATION _____ RAIL Left Right (Circle)

DATE _____ TIME _____ AM PM (Circle)

AIR TEMPERATURE _____ F*. WEATHER _____
RAIL TEMPERATURE _____ F*. _____

WELD KIT MANUFACTURER _____
RAIL GAP
NEAREST 1.6 MM _____
RAIL CUT REQUIRED? YES NO (Circle)
BACK RAIL
MANUFACTURER _____ USED RAIL? YES NO (Circle)
YEAR/MONTH ROLLED _____ HEAT NUMBER _____
_____

AHEAD RAIL
MANUFACTURER _____ USED RAIL? YES NO (Circle)
YEAR/MONTH ROLLED _____ HEAT NUMBER _____
_____

REMARKS_____
_____
_____

ULTRASONIC TEST DATE & RESULTS _____

KIT MFG. REPRESENTATIVE
PRESENT _____ WELDING FOREMAN _____
(Initial) (Signed)

CONTRACTING OFFICER'S
REPRESENTATIVE
PRESENT _____ RECORDER _____
(Initial) (Signed)

_____ RECORDER _____
(Initial) (Signed)

FOR GOVERNMENT USE ONLY

ULTRASONIC TEST DATE AND RESULTS _____

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*NOTE: Determination will be made to the nearest 1/2 degree.

-- End of Section --

SECTION 09915

COLOR SCHEDULE
06/93
AMENDMENT #0001

PART 1 GENERAL

1.1 GENERAL

This section covers only the color of the exterior and interior materials and products that are exposed to view in the finished construction. The word "color" as used herein includes surface color and pattern. Requirements for quality and method of installation are covered in other appropriate sections of the specifications. Specific locations where the various materials are required are shown on the drawings. Items not designated for color in this section may be specified in other sections. When color is not designated for items, the Contractor shall propose a color for approval.

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-14 Samples

Color board; GA.

2 sets of color boards, 120 days after the Contractor is given Notice to proceed, complying with the following requirements:

a. Color boards shall reflect all actual finish textures, patterns, and colors required for this contract.
b. Materials shall be labeled with the finish type, manufacturer's name, pattern, and color reference.

c. Samples shall be on size A4 or 8-1/2 by 11 inch boards with a maximum spread of size A1 or 25-1/2 by 33 inches for foldouts.

d. Samples for this color board are required in addition to samples requested in other specification sections.

e. Color boards shall be submitted to:
ARCHITECTURAL SECTION
DESIGN BRANCH
FORT WORTH DISTRICT.

PART 2 PRODUCTS

2.1 REFERENCE TO MANUFACTURER'S COLOR

Where color is shown as being specific to one manufacturer, an equivalent

color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers.

2.2 COLOR SCHEDULE

The color schedule lists the colors, patterns and textures required for exterior and interior finishes, including both factory applied and field applied colors.

2.2.1 Exterior Walls

Exterior wall colors shall apply to exterior wall surfaces including recesses at entrances and projecting vestibules. Conduit shall be painted to closely match the adjacent surface color. Wall color shall be provided to match the colors listed below.

a. STONE:
ACME; CENTURION GREAT LAKE S/F BLEND.

b. Mortar:
GRAY

c. Paint:
P1: EIFS SOFFIT TO BE PAINTED TO MATCH P1; KELLY-MOORE,WS1, CANVAS WHITE
P6: SHERWIN WILLIAMS; MOCKINGBIRD SW2006

NOTE: SEE ARCHITECTURAL DRAWINGS

d. GROUND,ORNAMENTAL, AND SPLIT-FACED Masonry Units (Integrally Colored):
GFMU: FEATHERLITE, TO MATCH BURNISHED MASONRY UNIT, CHARCOAL
OCMU: FEATHERLITE, TO MATCH BURNISHED MASONRY UNIT, CHARCOAL
SFCMU1; FEATHERLITE, TO MATCH BURNISHED MASONRY UNIT, TERRAZO
SFCMU2; FEATHERLITE, TO MATCH BURNISHED MASONRY UNIT, CHARCOAL

NOTE: SEE ARCHITECTURAL DRAWINGS FOR PLACEMENT AND BAND PATTERN.

e. Metal Wall Panels, Hardware, and Associated Trim:
BERRIDGE; PARCHMENT

f. EXTERIOR Insulation and Finish System:
EIFS1: STO, SMOKED PUTTY 93240
EIFS2: STO, STONEHENGE 20817

NOTE: SEE ARCHITECTURAL DRAWINGS FOR PLACEMENT.

h. Glass and Glazing: SPECIFIED IN SECTION 08810 GLASS AND GLAZING

2.2.2 Exterior Trim

Exterior trim shall be provided to match the colors listed below.

a. Doors and Door Frames/ROLLUP DOORS:
ALUMINUM: DARK ANODIZED BRONZE FINISH

STEEL: TO BE PAINTED TO MATCH P6, SHERWIN WILLIAMS MOCKINGBIRD SW2006.

ROLL-UP DOORS: TO BE PAINTED TO MATCH ADJACENT WALL COLOR.

b. Windows (mullion, muntin, sash, trim, and sill):
DARK ANODIZED BRONZE FINISH

e. Downspouts, Gutter, Louvers, and Flashings:
TO MATCH STANDING SEAM METAL ROOF; BERRIDGE, PARCHMENT

f. Handrails:
PAINTED TO MATCH STANDING SEAM METAL ROOF.

g. Soffits and Ceilings:
PAINTED TO MATCH P1; KELLY MOORE, WS1 CANVAS WHITE

h. Signage:
EXTERIOR SIGNS ARE SPECIFIED IN SECTION 10430 EXTERIOR SIGNAGE
SIGNAGE SHALL MATCH PHASE I & II

j. Caulking and Sealants:
TO MATCH ADJACENT WALL COLOR

2.2.3 Exterior Roof

Roof color shall apply to exterior roof surfaces including sheet metal flashings and copings, mechanical units, roof trim, pipes, conduits, electrical appurtenances, and similar items. Roof color shall be provided to match the colors listed below.

a. Metal:
BERRIDGE, PARCHMENT

2.2.4 Interior Floor Finishes

Flooring materials shall be provided to match the colors listed below.

c. Vinyl Composition Tile:
VCT1; ARMSTRONG, PEARL WHITE #51803

VCT2; ARMSTRONG, CHARCOAL #51915
VCT3; ARMSTRONG, CRANBERRY RED #51815

NOTE: SEE ARCH. DRAWINGS FOR PATTERN.

h. Ceramic Tile:
CT2; DAL-TILE, KEYSTONES, DK-04 FLINTLOCK, 25 X 25mm
CT7; DAL-TILE, KEYSTONES, DK-26 DARK GRAY, 25 X 25mm
CT9; DAL-TILE, KEYSTONES, DK-335 PORCELAIN, 25 X 25mm

NOTE: IN TOILET AREAS AND JANITOR CLOSET, PAINT WALL ABOVE WAINSCOT P2, SHERWIN WILLIAMS WHITE CLIFFS SW1024 UNLESS OTHERWISE INDICATED ON DRAWINGS. SEE ARCH. DRAWINGS FOR CERAMIC TILE PATTERN.

j. Grout:
GT1; CUSTOM BUILDING PRODUCTS, #9 NATURAL GRAY

n. Concrete: W/HARDNER

2.2.5 Interior Base Finishes

Base materials shall be provided to match the colors listed below.

a. Resilient Base and Edge Strips:
RB1; JOHNSONITE, CB-40 BLACK

c. Ceramic Tile:
CT4; MB-4C BUILT-UP BASE; DAL-TILE, KEYSTONES D311 EBONY 25 X 25mm

e. Grout:
GT1; CUSTOM BUILDING PRODUCTS, #9 NATURAL GRAY

2.2.6 Interior Wall Finishes

Interior wall color shall apply to the entire wall surface, including reveals, vertical furred spaces, grilles, diffusers, electrical and access panels, and piping and conduit adjacent to wall surfaces unless otherwise specified. Items not specified in other paragraphs shall be painted to match adjacent wall surface. Wall materials shall be provided to match the colors listed below.

a. Paint:
P1; KELLY-MOORE, WS1, CANVAS WHITE **(FACILITY SCALE HOUSE & SHED ONLY)**
P2; SHERWIN WILLIAMS, WHITE CLIFFS SW 1024
P3; SHERWIN WILLIAMS, SKYLINE STEEL SW1015
P4; KELLY-MOORE, AC28-N

b. INSUL METAL PANEL:
IMP; Berridge, Parchment

d. Ceramic Tile:
CT1; DAL-TILE, ACCENTIALS, D-115 FOG, 75 X 75 mm
CT3; DAL-TILE, ACCENTIALS DP-263 BLUSH MIST 75 X 75mm
CT4; DAL-TILE, KEYSTONES D311 EBONY 25 X 25 mm
CT5; DAL-TILE, KEYSTONES D017 RED 25 X 25mm
CT6; DAL-TILE, KEYSTONES D055 CANARY 25 X 25mm
CT8; DAL-TILE, LINER, K111 BLACK 12 X 150mm

NOTE: SEE ARCH. DRAWINGS FOR PATTERN.

e. Ceramic Tile Grout:
GT2; CUSTOM BUILDING PRODUCTS, #386 OYSTER GRAY

f. EXTERIOR INSULATION FINISH SYSTEM:
STO; SMOKED PUTTY 93240

2.2.7 Interior Ceiling Finishes

Ceiling colors shall apply to ceiling surfaces including soffits, furred down areas, grilles, diffusers, registers, and access panels. Ceiling color shall also apply to joist, underside of roof deck, and conduit and piping where joists and deck are exposed and required to be painted. Ceiling materials shall be provided to match the colors listed below.

a. Acoustical Tile and Grid:
ATC1; ARMSTRONG, CROSSGATE LINEAR BEVELED, WHITE

b. Paint:
P1; KELLY-MOORE, WS1 CANVAS WHITE

c. LINEAR METAL CEILING:
INTERFINISH; TO MATCH P1, KELLY MOORE, WS1, CANVAS WHITE

2.2.8 Interior Trim

Interior trim shall be provided to match the colors listed below.

a. Doors:
STEEL; PAINTED TO MATCH ADJACENT WALLS
WOOD; STAINED, DARK RED MAHONGANY

b. Door Frames:
P2; SHERWIN WILLIAMS, WHITE CLIFFS SW1024

c. Windows (mullion, muntin, sash, trim, and stool):
P2; SHERWIN WILLIAMS, WHITE CLIFFS SW1024

d. Window Sills:
P2; SHERWIN WILLIAMS, WHITE CLIFFS SW1024

e. Fire Extinguisher Cabinets:
STAINLESS STEEL

f. Handrails:
P6; SHERWIN WILLIAMS, MOCKINGBIRD SW2006

2.2.9 Interior Window Treatment

Window treatments shall be provided to match the colors listed below.

a. Horizontal Blinds:
LEVOLOR; RIVIERA 136 ANTIQUE WHITE, 25mm, 8 GAUGE ALUMINUM

NOTE: ALL EXTERIOR WINDOWS TO HAVE MINI-BLINDS INSTALLED

2.2.10 Interior Miscellaneous

Miscellaneous items shall be provided to match the colors listed below.

a. Toilet Partitions and Urinal Screen:
COMTEC INDUSTRIES, MIDNITE BLACK, #S205

b. Plastic Laminate:
PL1; NEVAMAR, BIRCH MATRIX, MR-6-8T
PL2; NEVAMAR, GRAY MATRIX, MR-6-1T
PL3; NEVAMAR, BLACK PEARL, S-6-14T

NOTE: SEE ARCH. DRAWINGS FOR INSTALLATION PLACEMENT.

c. Signage Message Color (excluding handicapped signage):
TO MATCH PHASE I & II

d. Signage Background Color (excluding handicapped signage):
TO MATCH PHASE I & II

e. Lockers:
P4; TO MATCH KELLY-MOORE, AC28-N

g. WALL/Corner Guards:
CLEAR ACRYLIC FINISH

NOTE: SEE ARCH. DRAWINGS FOR PLACEMENT

h. Wall Switch Handles and Standard Receptacle Bodies:
STAINLESS STEEL

i. Electrical Device Cover Plates and Panels:
STAINLESS STEEL

j. GRILLS AND/OR DIFFUSERS:
GRILLS AND/OR DIFFUSERS ON GYPSUM BOARD TO BE PAINTED TO MATCH ADJACENT CEILING OR WALL COLOR.

k. DUCTS:
EXPOSED DUCTS SHALL BE PAINTED P1, KELLY MOORE, CANVAS WHITE

3.1 ROOM COLOR AND FINISH SCHEDULE

I - ENGINE MAINTENACE FACILITY

Area: RM E101 OFFICE

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P2	P2	P2	P2	ACT1

Area: RM E102 Repair Bay

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	IMP	IMP	IMP	IMP	ES (P1)
			P3	P3	P3	P3	

Note: Wainscot paint height at 1200mm. All doors to be painted P6 except rolling doors and hood that are to be painted to match IMP (Insul Metal Panel) in a semi-gloss finish. Exposed structural ridge frame and end wall support to be painted P1. Handrails to be painted P6 in a gloss finish. Exposed roof, structural and deck to be painted P1 in a semi-gloss finish.

Area: RM E103 Repair Bay

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	IMP	IMP	IMP	IMP	ES (P1)
			P3	P3	P3	P3	

Note: Wainscot paint height at 1200mm. All doors to be painted P6 except rolling doors and hood that are to be painted to match IMP (Insul Metal Panel) in a semi-gloss finish. Exposed structural ridge frame and end wall support to be painted P1. Handrails to be painted P6 in a gloss finish. Exposed roof, structural and deck to be painted P1 in a semi-gloss finish.

Area: RM E104 Corridor

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	P2	P2	P2	P2	P1
			P4	P4	P4	P4	

Note: Wainscot color P4 from floor to 1200mm, P2 remaining wall above.

Area: RM E105 Mens Toilet

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT4	CT2	P2	P2	P2	P2	P1
		CT7	CT3	CT3	CT3	CT3	
		CT9	CT4	CT4	CT4	CT4	
			CT5	CT5	CT5	CT5	
			CT6	CT6	CT6	CT6	
			CT8	CT8	CT8	CT8	

Note: Ceramic Tile (CT) wainscot from floor to 1200mm, painted P2 above wainscot in semi-gloss finish. See Arch. Drawings for Wall and Floor patterns.

Area: RM E106 Womens Toilet

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT4	CT2	P2	P2	P2	P2	P1
		CT7	CT3	CT3	CT3	CT3	
		CT9	CT4	CT4	CT4	CT4	
			CT5	CT5	CT5	CT5	
			CT6	CT6	CT6	CT6	
			CT8	CT8	CT8	CT8	

Note: Ceramic Tile (CT) wainscot from floor to 1200mm, painted P2 above wainscot in semi-gloss finish. See Arch. Drawings for Wall and Floor patterns.

Area: RM E107 Janitor

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING

Matl.:	CT4	CONC	P2 CT1	P2 CT1	P2 CT1	P2 CT1	P1

Note: Ceramic Tile (CT) wainscot from floor to 1800mm, painted P2 above wainscot in semi-gloss finish. Storage shelvings shall match P1.

Area: RM E108 Electrical Room

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P2	P2	P2	P2	ES

Area: RM E109 Commnications

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P2	P2	P2	P2	ES

Area: RM E110 Solvent Wash

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT1	CONC	P2 CT1	P2 CT1	P2 CT1	P2 CT1	P1

Note: Ceramic Tile (CT) wainscot from floor to 1200mm, painted P2 above wainscot in semi-gloss finish.

Area: RM E111 Mechanical

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	P3	P3	P3	P3	P1

Area: RM E112 Oil Storage

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	P3	P3	P3	P3	P1

Note: Wainscot to be painted with an epoxy paint from floor to 1800mm.

Area: RM E113 Pump Room

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	P3	P3	P3	P3	P1

11 - VEHICLE WASH

Area: RM V101 Wash Bay

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	P3		P3		ES(P1)

Area: RM V102 Wash Bay

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	P3		P3		ES(P1)

Area: RM V103 Equipment Room

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	P3	P3	P3	P3	ES(P1)

Area: RM V104 Mech/Electrical Room

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	P3	p3	P3	p3	ES(P1)

Area: RM V105 Mens Toilet

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT4	CT2 CT7	P2 CT3	P2 CT3	P2 CT3	P2 CT3	P1

CT9	CT4	CT4	CT4	CT4
	CT5	CT5	CT5	CT5
	CT6	CT6	CT6	CT6
	CT8	CT8	CT8	CT8

Note: Ceramic Tile (CT) wainscot from floor to 1200mm, painted P2 above wainscot in semi-gloss finish. See Arch. Drawings for Wall and Floor patterns.

Area: RM V106 Womens Toilet

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT4	CT2	P2	P2	P2	P2	P1
		CT7	CT3	CT3	CT3	CT3	
		CT9	CT4	CT4	CT4	CT4	
			CT5	CT5	CT5	CT5	
			CT6	CT6	CT6	CT6	
			CT8	CT8	CT8	CT8	

Note: Ceramic Tile (CT) wainscot from floor to 1200mm, painted P2 above wainscot in semi-gloss finish. See Arch. Drawings for Wall and Floor patterns.

Area: RM V107 Wash Bay

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	P3		P3		ES(P1)

Area: RM V108 Wash Bay

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	P3		P3		ES(P1)

III - DRRF

Area: RM D101 Reception

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P2	P2	P2	P2	ACT1
		VCT2	P3	P3	P3	P3	
		VCT3					

Note: See Arch. Drawings for VCT pattern and counter/cabinet details. Acoustical Ceiling pattern shall be installed with rib pattrn perpendicular to the north side. Wainscot shall be P3 from floor to 1200mm.

Area: RM D102 TCCCIS Area

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P2	P2	P2	P2	ACT1

Area: RM D103,109 Corridor

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P2	P2	P2	P2	ACT1
		VCT2	P3	P3	P3	P3	
		VCT3					

Note: See Arch. Drawings for VCT pattern. Acoustical Ceiling pattern shall be installed with rib pattrn perpendicular to the north side. Wainscot shall be P3 from floor to 1200mm.

Area: RM D104 Documentation

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING

Matl.:	RB1	VCT1	P2	P2	P2	P2	ACT1

Area: RM D105 Unit

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P2	P2	P2	P2	ACT1

Area: RM D106 Vending

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P4	P4	P4	P4	ACT1
		VCT2				P1	
		VCT3					

Note: See Arch. Drawings for VCT pattern. Acoustical Ceiling pattern shall be installed with rib pattrn perpendicular to the north side. Wainscot shall be P3 from floor to 1200mm.

Area: RM D107 Unisex Toilet

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT4	CT7	P2	P2	P2	P2	P1
			CT3	CT3	CT3	CT3	
			CT4	CT4	CT4	CT4	
			CT5	CT5	CT5	CT5	
			CT6	CT6	CT6	CT6	
			CT8	CT8	CT8	CT8	

Note: Ceramic Tile (CT) wainscot from floor to 1200mm, painted P2 above wainscot in semi-gloss finish. See Arch. Drawings for wall pattern.

Area: RM D108 Break Room

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P2	P4	P2	P2	ACT1
		VCT2					
		VCT3					

Area: RM D110 Electrical Room

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	P3	P3	P3	P3	P1

Area: RM D111 Communications Room

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P3	P3	P3	P3	P1

Area: RM D112 Janitor

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT4	CT7	P2	P2	P2	P2	P1
			CT1	CT1	CT1	CT1	

Note: Ceramic Tile (CT) wainscot from floor to 1800mm, painted P2 above wainscot in semi-gloss finish. See Arch. Drawings.

Area: RM D113 Mechanical Room

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P3	P3	P3	P3	ES

Area: RM D114 Male Latrine

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT4	CT2	P2	P2	P2	P2	P1
		CT7	CT3	CT3	CT3	CT3	

CT9	CT4	CT4	CT4	CT4
	CT5	CT5	CT5	CT5
	CT6	CT6	CT6	CT6
	CT8	CT8	CT8	CT8

Note: Ceramic Tile (CT) wainscot from floor to 1200mm, painted P2 above wainscot in semi-gloss finish. See Arch. Drawings for wall and floor pattern.

Area: RM D115 Urinal Area

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT4	CT2	P2	P2	P2	P2	P1
		CT7	CT3	CT3	CT3	CT3	
		CT9	CT4	CT4	CT4	CT4	
			CT5	CT5	CT5	CT5	
			CT6	CT6	CT6	CT6	
			CT8	CT8	CT8	CT8	

Note: Ceramic Tile (CT) wainscot from floor to 1200mm, painted P2 above wainscot in semi-gloss finish. See Arch. Drawings for wall and floor pattern.

Area: RM D116 Lavatory Area

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT4	CT2	P2	P2	P2	P2	P1
		CT7	CT3	CT3	CT3	CT3	
		CT9	CT4	CT4	CT4	CT4	
			CT5	CT5	CT5	CT5	
			CT6	CT6	CT6	CT6	
			CT8	CT8	CT8	CT8	

Note: Ceramic Tile (CT) wainscot from floor to 1200mm, painted P2 above wainscot in semi-gloss finish. See Arch. Drawings for wall and floor pattern.

Area: RM D117 Entry

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT4	CT2	P2	P2	P2	P2	P1
		CT7	CT3	CT3	CT3	CT3	
		CT9	CT4	CT4	CT4	CT4	
			CT5	CT5	CT5	CT5	
			CT6	CT6	CT6	CT6	
			CT8	CT8	CT8	CT8	

Note: Ceramic Tile (CT) wainscot from floor to 1200mm, painted P2 above wainscot in semi-gloss finish. See Arch. Drawings for wall and floor pattern.

Area: RM D118 Exterior Alcove

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		CONC	EIFS1	EIFS1	EIFS1		EIFS1

Area: RM D119 Entry

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT4	CT2	P2	P2	P2	P2	P1
		CT7	CT3	CT3	CT3	CT3	
		CT9	CT4	CT4	CT4	CT4	
			CT5	CT5	CT5	CT5	
			CT6	CT6	CT6	CT6	
			CT8	CT8	CT8	CT8	

Note: Ceramic Tile (CT) wainscot from floor to 1200mm, painted P2 above wainscot in semi-gloss finish. See Arch. Drawings for wall and floor pattern.

Area: RM D120 Female Latrine

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	CT4	CT2	P2	P2	P2	P2	P1
		CT7	CT3	CT3	CT3	CT3	
		CT9	CT4	CT4	CT4	CT4	
			CT5	CT5	CT5	CT5	
			CT6	CT6	CT6	CT6	
			CT8	CT8	CT8	CT8	

Note: Ceramic Tile (CT) wainscot from floor to 1200mm, painted P2 above wainscot in semi-gloss finish. See Arch. Drawings for wall and floor pattern.

Area: RM D121 Storage

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P2	P2	P2	P2	P1

III - FACILITY SCALE HOUSE & SHED

Area: RM S101 Control Room

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P1	P1	P1	P1	P1

Area: RM S102 Storage Room

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P1	P1	P1	P1	P1

IV - Tower

Area: RM T101 Control Room

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:	RB1	VCT1	P2	P2	P2	P2	P1

Area: RM T102 Observation Deck

	BASE	FLOOR	A WALL	B WALL	C WALL	D WALL	CEILING
Matl.:		Steel Grating	P3	P3	P3	P3	MTL

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 14601

CRANE, GANTRY, TOP RUNNING, 4-TON MAXIMUM CAPACITY
04/94
Amendment 0001

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA Std 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
AFBMA Std 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 390.03a	(1980; Errata 1983; R 1988) Gear Handbook Gear Classification, Materials and Measuring Methods for Bevel, Hypoid, Fine Pitch Wormgearing and Racks Only as Unassembled Gears (Partially replaced by AGMA 2000-A)
AGMA 2000-A	(1988; Errata Jan 89, Errata Jul 90) Gear Classification and Inspection Handbook, Tolerances & Measuring Methods for Unassembled Spur and Helical Gears (including Metric Equivalents)
AGMA 2001-C	(1995) Fundamental Rating Factors & Calculation Methods for Involute Spur and Helical Gear Teeth
AGMA 6010-F	(1997) Standard for Spur, Helical, Herringbone and Bevel Enclosed Drives
AGMA 6019-E	(1989; R 1994) Gearmotors Using Spur, Helical, Herringbone, Straight Bevel, or Spiral Bevel Gears
AGMA 6021-G	(1989; R 1994) Shaft Mounted and Screw Conveyer Drives Using Spur, Helical and Herringbone Gears

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC Pub No. S329	(1985; Appx A Jun 1994) Allowable Stress Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C80.1	(1995) Rigid Steel Conduit - Zinc Coated

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 159	(1983; R 1993) Automotive Gray Iron Castings
ASTM A 325	(1997) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(1997) High-Strength Bolts for Structural Steel Joints (Metric)
ASTM A 490	(1997) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A 490M	(1993) High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A 668/A 668M	(1996) Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 209M	(1995) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 438/B 438M	(1995a) Sintered Bronze Bearings (Oil-Impregnated)
ASTM B 439	(1995) Iron-Base Sintered Bearings (Oil-Impregnated)
ASTM B 612	(1996) Iron Bronze Sintered Bearings (Oil-Impregnated)

ASME INTERNATIONAL (ASME)

ASME B30.2	(1996) Overhead and Gantry Cranes Top Running Bridge, Single or Multiple Girder Top Running Trolley Hoist

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel
AWS D14.1	(1997) Welding Industrial and Mill Cranes and Other Material Handling Equipment

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-55810 (Apr 1996) Conduit, Metal, Flexible

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA 397 (1972; R 1979; 397-1 1980) Recommended Standard for) Thyristors

FEDERAL SPECIFICATIONS (FS)

FS RR-W-410 (Rev D; Am 1) Wire Rope and Strand

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 597 (1983; R 1992) Practices and Requirements for General Purpose Thyristor for DC Drives

MATERIAL HANDLING INDUSTRY (MHI)

MHI CMAA 70 (1994) Electric Overhead Traveling Cranes

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1 (1993) Molded Case Circuit Breakers and Molded Case Switches

NEMA ICS 1 (1993) Industrial Controls and System

NEMA ICS 2 (1993) Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC

NEMA ICS 3 (1993) Industrial Control and Systems: Factory Built Assemblies

NEMA ICS 4 (1993 Rev Industrial Control and Systems: Terminal Blocks

NEMA ICS 6 (1993) Industrial Control and Systems: Enclosures

NEMA MG 1 (1993; Rev 1; Rev 2; Rev 3; Rev 4)) Motors and Generators

NEMA ST 1 (1988; R 1994) Specialty Transformers (Except General-Purpose Type)

NEMA WC 3 (1992; Rev 1) Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NEMA WC 7 (1988; Rev 1; Rev 2) Crosslinked-Thermosetting-polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NEMA WC 8	(1988; Rev 1;Rev 2; Rev 3) Ethylene-Propylene-Rubber- Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 489	(1996) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 943	(1993; Rev thru May 1998) Ground-Fault Circuit-Interrupters
UL 1004	(1994; Rev thru Dec 1997) Electric Motors
UL 1449	(1996; Rev thru Oct 1998) Transient Voltage Surge Suppressors

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

1.2.1.1 Standard Products

Materials and equipment shall be standard products of manufacturers regularly engaged in the fabrication of cranes and shall essentially duplicate items which have been in satisfactory use for at least 2 years prior to bid opening. Any company licensed by a crane manufacturer to manufacture cranes bearing their name shall have the design and components approved by the licensor prior to submission to the Government for approval.

1.2.1.2 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or catalog number, and serial number on a metal plate secured to the equipment.

1.2.1.3 Verification of Dimensions

The Contractor shall verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing any work.

1.2.1.4 Welding

Welding shall be in accordance with qualified procedures using AWS D14.1 as modified. Written welding procedures shall specify the Contractor's standard dimensional tolerances for deviation from camber and sweep and such tolerances shall not exceed those specified in AWS D14.1. All welding shall be performed indoors. Welders and welding operators shall be qualified in accordance with AWS D1.1 or AWS D14.1. Allowable stress values shall be in accordance with MHI CMAA 70.

1.2.2 Design Criteria

The cranes shall be designed to operate in the spaces. **(AM#1)**

1.2.2.1 Classification

The crane shall be designed and constructed to MHI CMAA 70 Class B, Service requirements for operation in outdoor nonhazardous environment.

1.2.2.2 Rated Capacity and Speeds

The rated capacity of the crane shall be 2.03 metric tons. The lower load block and hook shall not be considered part of the rated capacity. Rated speeds (in mm/s) for the hoist, gantry and trolley shall be as follows:

Rated Speeds

	Maximum
Main Hoist	50
Trolley	100
Gantry	175

1.2.2.3 Capacity Plates

Two capacity plates shall be provided, one for each side of the gantry. Each plate shall be lettered to indicate the total rated hoisting capacity of the crane. All lettering shall be of sufficient size to be easily read from the floor. Each lower load block shall be marked with the hoist rated capacity.

1.2.2.4 Stability

The gantry crane shall have a minimum factor of safety of 1.25 against overturning under each condition of loading stated in paragraph 3.3.2.4 of MHI CMAA 70. Counterweights shall be provided if necessary to obtain the required stability.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Gantry Crane System; GA.

A complete list of equipment and materials, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions.

Spare Parts; FIO.

Spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 3months prior to the date of beneficial occupancy. The data shall include a

complete list of parts and supplies, with current unit prices and source of supply.

SD-06 Instructions

Gantry Crane System; FIO.

Diagrams, instructions, and other sheets proposed for posting.

SD-09 Reports

Acceptance Testing; GA.

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The report shall include the information as required by paragraph ACCEPTANCE TESTING.

SD-18 Records

Hooks; GA.

Record of hook material and any heat treatment performed shall be stamped on the hook shank or documented in certification papers furnished with the hooks.

SD-19 Operation and Maintenance Manuals

Gantry Crane System; GA.

Six copies of operation manuals and six copies of maintenance manuals shall be supplied for the equipment furnished. One complete set shall be furnished prior to performance testing and the remainder upon acceptance. Operation manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Operation manuals shall include a copy of the acceptance test report for information and future reference. Operation manuals shall include an overall description of the system describing any unique features that may need special attention. Maintenance manuals shall provide step-by-step description of routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping layout diagrams, equipment layout diagrams, and detailed wiring and control diagrams of the system as installed. Maintenance manuals shall include a spare parts list of manufacturer's recommended spare parts that should be maintained on-site and any long lead time items should be clearly identified. Operation and maintenance manuals shall be approved prior to the field training course.

1.4 DELIVERY AND STORAGE

Equipment delivered shall be placed in indoor storage, protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 STRUCTURAL MATERIALS

2.1.1 Bolts, Nuts, and Washers

Bolts, nuts, and washers shall conform to ASTM A 325M bolts. High strength bolted connections shall conform to the requirements of AISC Pub No. S329, except that ASTM A 490M bolts shall not be used. No galvanized bolts shall be used.

2.1.2 Gantry Girders

Gantry girders shall be wide flange beams, standard I-Beams, reinforced beams or sections fabricated from rolled plates and shapes.

2.1.3 Gantry Rails

The gantry rail shall be fastened to the top cover plate with welded clips. Gantry rail joints shall be bolted using standard joint bars. Rail joints shall be staggered.

2.1.4 End Ties and Gantry Girder End Connections

Horizontal gusset plates shall be provided at the elevation of the top and bottom end tie flanges for connection to girder ends. End connections shall be made using high-strength bolts. Body bound bolts fitted in drilled and reamed holes shall be used to maintain the crane square.

2.1.5 Gantry End Trucks

End trucks shall be fabricated from structural steel providing a rigid structure and shall be the rotating or fixed axle type. Jacking pads shall be provided for removal of wheel assemblies.

2.1.6 Trolley Frame

Trolley frame shall consist of two structural steel side frames or trucks welded together with one or more structural steel load girts to form a one-piece unit. Pads shall be provided for the use of jacks or wedges when changing truck wheels.

2.1.7 Stops and Bumpers

Bumpers shall be provided on the gantry to engage bumpers located at the ends of the runway rails. Bumpers shall be provided on the trolley to engage bumpers located at the ends of the gantry rails. Stops shall be located to permit maximum gantry and trolley travel. Structural stops and bumpers shall be designed and installed in accordance with MHI CMAA 70.

2.1.8 **deleted (AM#1)**

2.1.9 Runway Rails

The runway rails for the gantry travel shall be of the size recommended by

the crane manufacturer and shall be in accordance with MHI CMAA 70.

2.1.10 **delete (AM#1)**

2.2 MECHANICAL EQUIPMENT

2.2.1 Drives

2.2.1.1 Gantry Drives

Gantry drives shall be A-4 drive arrangement as specified in MHI CMAA 70.

2.2.1.2 Trolley Drives

The trolley shall have a drive arrangement that has two wheels driven.

2.2.2 Load Blocks

2.2.2.1 Main Hoist Load Blocks

Load blocks shall be of steel construction. The load block frame shall be completely enclosed except for rope openings. Load blocks shall be provided with a forged steel crosshead, separate from the sheave pin, with swivel mounting for the hook. Sheave bearing lubrication fittings shall be recessed within the sheave pin or adequately guarded to prevent damage.

2.2.2.2 Hook Assembly

Hooks shall be single barbed and shall be made of forged steel complying with ASTM A 668/A 668M. All hooks shall be fitted with safety latches designed to preclude inadvertent displacement of slings from the hook saddle. No painting or welding shall be performed on the hook. Hooks are required to be periodically disassembled, inspected, and nondestructively tested; therefore the hook nut shall be secured by a set screw or other similar, easily removable securing device, but shall not be welded. Hooks shall be commercially rated and shall have a minimum proof load of twice the safe working load and have a minimum straightening load of four times the safe working load.

2.2.3 Hoisting Ropes

Hoisting ropes shall be regular lay, preformed, uncoated, improved or extra improved plow steel, 6 by 37 construction, with independent wire rope core conforming to FS RR-W-410, Type I, Class 3. The hoisting ropes shall be selected such that the rated capacity load plus the load block weight divided by the number of parts of rope shall not exceed 20 percent of the certified breaking strength of the rope. Hoisting ropes shall be secured to the hoist drum so that no less than three wraps of rope remain at each anchorage of the hoist drum at the extreme low position (limit switch stop).

2.2.4 Sheaves

Sheaves shall be of cast steel, forged, rolled, or welded structural steel. Sheave grooves shall be accurately machined, smoothly finished, and free of surface defects.

2.2.5 Hoist Drums

Hoist drums shall be of welded rolled structural steel, cast steel, or seamless steel pipe. Drums shall be machined and provided with grooves, including two dead grooves at each of the two anchor points.

2.2.6 Gearing

Gearing shall be of the enclosed (gear reducers) or open type. The gears and pinions shall be spur, helical, or herringbone type only, and shall be forged, cast or rolled steel, except that drum gears may be of welded construction.

2.2.6.1 Gear Reducers

Gear reducers shall be the standard items of manufacturers regularly engaged in the design and manufacture of gear reducers, or they shall be integral components of standard hoists or hoist/trolley units of manufacturers regularly engaged in the design and manufacture of hoists or hoist/trolley units. Gear reducers shall be designed, manufactured, and rated in accordance with AGMA 6010-F, AGMA 6019-E, or AGMA 6021-G(for trolley drives only), as applicable.

2.2.6.2 Open Gearing

Open gears shall be enclosed with safety guards provided with openings with covers for inspection and access for grease lubrication.

2.2.7 Brakes

Brakes shall be shoe or disc with thermal capacity suitable for Class B Service. Shoe and disc brakes shall be spring set and electrically released by a continuously rated direct acting magnet. All brakes shall be self-aligning and provide for easy adjustment for torque setting and lining wear. Brake wheels shall be cast iron conforming to ASTM A 159 or shall be the manufacturer's standard high-strength ductile cast iron, provided that the material exhibits wear characteristics in the form of powdered wear particles and is resistant to heat checking. Disc brakes shall be totally enclosed and have multiple discs with stationary releasing magnets. Brake torque shall be easily adjustable over a 2:1 torque range.

2.2.7.1 Hoist Holding Brakes

Each hoist shall be equipped with at least two holding brake(s). The holding brake shall be a friction brake of the shoe design and shall be applied to the motor shaft or to the gear reducer shaft.

2.2.7.2 Hoist Control Brake

Each hoist shall be equipped with an integral mechanical load brake-"Weston" or multiple-disc. The multiple-disc brake shall be provided with external adjustment for wear.Each hoist shall be provided with an electric control brake to prevent overspeeding.

2.2.7.3 Trolley Brake

The trolley braking system shall have shoe or disc brakes that are spring

applied and electrically released.

2.2.7.4 Gantry Brakes

The gantry braking system shall provide a single-shoe or disc brake for each gantry drive motor. The gantry brakes shall be spring applied and electrically released.

2.2.8 Wheels

The wheels shall be made of rolled or forged steel. The wheel treads and flanges shall be rim toughened to between 320 and 370 Brinell hardness number. Gantry and trolley wheels shall be double flanged. Trolley wheels shall have straight treads. Gantry wheels shall have straight treads.

2.2.9 Bearings

All bearings, except those subject only to small rocker motion, shall be of the antifriction type. Load ratings and fatigue life shall be in accordance with AFBMA Std 9and AFBMA Std 11. Equalizer sheaves shall be equipped with sintered oil impregnated type bushings in accordance with ASTM B 438/B 438M, ASTM B 439, or ASTM B 612.

2.2.10 Antidrip Provisions

The cranes shall be designed to preclude leakage of lubricants onto the lifted loads or the floor. Equipment and components which cannot be made leak-proof shall be fitted with suitable drip pans. The drip pans shall be made of steel and shall be designed to permit removal of the collected lubricant.

2.2.11 Lubrication System

A splash oil lubrication system shall be provided for the hoist, trolley and gantry gear cases, except that an oil pump shall be used on vertical mounted gear cases exceeding two reductions. Oil pumps shall be reversible and capable of maintaining the same oil flow direction and volume while being driven in either direction. Electric motor-driven pumps may be used when the input shaft speed is too low at any operating condition to ensure adequate oil flow. In such applications, the pump shall be energized whenever the drive mechanism brakes are released.

2.2.11.1 Electrically Driven Oil Pump Alarm

If an electric-driven lubricating pump is used, an audible alarm and red indicating light shall be provided and shall be energized in the event of pump malfunction.

2.3 ELECTRICAL COMPONENTS

2.3.1 Power Supply

2.3.1.1 General

Electric power for the normal operation of the crane will be supplied by a Government furnished and installed feeder from the nominal 480 volt, three-phase, 60-Hz, AC, ungrounded power distribution system. The main contact conductor system will be located as shown the drawings. The power

shall be brought into the crane by a suitable collector. The main contact conductor and collector system shall be furnished by the Contractor and the contact conductor system and all the required mounting accessories shall be delivered to the site for installation by the Government under another contact.

2.3.1.2 Incoming Power Supply

a. General - Incoming power from the above power receptacles shall be brought into the crane by means of a Type G, three-conductor, 600-volt rubber or rubber-like insulated and extra-heavy-duty neoprene-jacketed portable power cable. The cable shall have a usable length of not less than 75 meters, and shall be wound upon the cable reel to be furnished and mounted on the crane. The power plug shall be installed on the free end of the cable and an anchorage shall be provided to relieve the power plug and receptacle from the strain of reeling and unreeling the cable. The grounding conductors shall make electrical connection to the crane structure through the fourth collector ring and brush of the cable reel and shall be connected to the ground terminal of the power plug.

b. Cable Reel - The cable reel shall be rated for constant duty, 50 amperes continuous, 600-volt AC, shall be provided with four collector rings and brushes, shall be of weather-proof construction, shall maintain approximately uniform tension in the cable, and shall automatically "pay out" and "take up" the cable as required by the crane travel. The cable reel shall be provided with a positive driven or actuated limit switch that will prevent excess "takeup". The reel shall be mounted on the crane in a location, as approved , that will allow ready maintenance and inspection as well as satisfactory operation.

2.3.1.3 Main Contact Conductors and Collectors

The contact conductor system shall be furnished complete with collector and all necessary accessories for mounting the contact assembly as shown.

a. Conductor - The contact conductor system shall be enclosed and shall be rated for 600 volts AC. It shall have a continuous current carrying capacity as required by the connected load of the crane and as required to hold the voltage drop to not more than 1 percent from the power input connection at the main contact conductors to the input terminals of the crane main circuit breaker when the crane is operating with the greatest load condition and is at the maximum distance from the point of connection of the power feeder. Mounting supports shall provide means to accommodate contraction and expansion due to temperature changes and to permit installation with proper alignment. The mounting supports shall be spaced at intervals that will limit the maximum deflection of the contact conductors to not more than 2 mm, but in no case shall the spacing intervals of the supports be more than 3 m. All mounting bolts and screws shall be of a suitable corrosion resisting material. Standard products of the manufacturer furnishing the conductors shall be provided to connect the power supply to the conductors. Contraction and expansion sections shall be provided at each monolith joint. Except as otherwise specified, the contact conductor system shall conform to the following:

(1) Conductor insulation shall be nonburning and suitable for

outdoor service at an ambient temperature of 40 degrees C. It shall be designed and installed to accommodate independent and/or unequal movements of the conductors and enclosures.

(2) Stainless steel hanger clamps with insulators shall be used to support the insulated conductor.

(3) An ice shield shall be provided and arranged to prevent icing of the conductors or collectors. The shield, shield straps, and strap nuts shall be made of aluminum conforming to ASTM B 209M, Alloy 3003, Temper H14. The shields shall be not less than 1.25 mm in thickness and the shield strap nuts shall be not less than 3.20 mm in thickness. Bolts and screws shall be made of stainless steel. The ice shield shall be provided with expansion and contraction joints.

b. Collector - Collector shall have two individually spring loaded conductor contact shoes for each phase or for each main conductor, shall have no exposed current carrying surfaces, and shall be articulated, if necessary, to maintain full contact against the contact conductor. Contact shoes shall be of graphite bronze or other suitable material as approved and shall be suitable for use with contact conductors furnished. The collector mounting shall provide means for adjustment as required to make proper contact and to travel properly on the contact conductors. Supporting wheels, if required, shall be provided with self-lubricating bearings.

2.3.1.4 Incoming Power Circuit Breaker

The crane's normal power supply shall be controlled by means of a 460volt, three-pole, manually operated air circuit breaker having a suitable ampere rating. Short circuit protection only shall be provided. The breaker shall be mounted on the protective panel.

2.3.2 TROLLEY CONDUCTORS AND COLLECTORS

2.3.2.1 Festoon Conductors

Power and control circuits may be brought to the crane trolley by means of a "festoon" system consisting of jacketed and color coded multiple conductor power and control cables which shall be bundled and supported by four-wheel trolleys running on "I" beam rails mounted on the inside of the main trolley girders. Trolley wheels shall be provided with antifriction bearings. The conductors of all cables shall be terminated at each end by terminal lugs connected to terminal blocks conforming to NEMA ICS 4mounted in cast iron junction boxes of NEMA Type 4 construction conforming to Part ICS-1-110 of NEMA ICS 1. Power and control circuits shall be segregated and terminated in separate junction boxes. Two extra conductors shall be provided in each control cable. All cable of a given "festoon" group shall be bundled together using nylon lacing material. All cables shall be supported with sufficient trolleys to maintain a minimum of 900 mmfrom the top of the lifting beam.

2.3.3 Control Systems

A separate controller shall be provided for each motor; however, a duplex controller shall be used for two motor gantry drives. Overload protection shall be in conformance with the requirements of NEMA ICS 2. Contactors

that are used for starting, stopping, and reversing shall be mechanically and electrically interlocked.

2.3.3.1 Hoist Control System

a. Motion Control - The main hoist motion control system shall be single - speed, with AC magnetic control of AC squirrel cage motors
b. Motor Control - The hoist motor control shall provide five-speed AC magnetic control of AC wound rotor motor with eddy-current braking. The eddy-current brake shall provide an adjustable varying artificial loading of the wound rotor hoist motor on at least two hoisting points and on four lowering points. Operation of the hoist shall be prevented upon loss of eddy-current brake excitation. Eddy-current brake shall be excited with reduced voltage when the hoist control is in the OFF position. There shall be positive drive down on all lowering points. On the first speed-point hoisting, the hook shall not lower with 100 percent of rated load and the no-load hook speed shall not exceed 30 percent of rated speed. On the first speed-point lowering, the full-load hook speed shall not exceed 18 percent of rated speed. As an additional feature, a self-excited alternator shall be mounted on the electric load brake housing to excite the load brake if the power supply fails.

c. Motor Control - The hoist motor control shall provide AC static stepless control. The control shall provide for continuously adjustable speeds throughout the range from minimum speed to maximum speed. Eddy-current braking shall provide a retarding torque for control of light loads in the hoisting direction and all loads in the lower direction of subsynchronous speed. To reduce holding brake wear, the control shall be arranged so that the electric load brake is effective in slowing the motion when the control is in the OFF position. The minimum hoist position of the control shall not allow the hook to lower with full rated load on the hook. Minimum lowering speed at rated hook load shall not exceed 15 percent of rated speed. Minimum speed hoisting with an empty hook shall not exceed 20 percent of synchronous motor speed. All loads up to 100 percent rated capacity shall raise on the minimum speed point of the master.

2.3.3.2 Travel Control System

The gantry and trolley motion control system shall be single-speed with AC magnetic control of squirrel cage motors

a. Gantry and Trolley Control - The gantry and trolley main control systems shall provide two speeds in each direction by means of an electrically operated, full magnetic, across-the-line reversing type starter. Centrifugal switches shall be provided and used in the control circuit to prevent the plugging of trolley or gantry drive motors; each switch shall be arranged to set the associated drive's brake while attempts are made to plug. The gantry and trolley main control system shall be provided with primary resistor reduced voltage starting, acceleration, and deceleration for all speed points.

b. Drift Point - With the master switch in the "Off" position, operation of a thumb-operated auxiliary switch in the operating lever shall actuate the drift position. In the "Drift" position, the electric brakes shall be released and the crane travel motor or motors

de-energized to allow full control of drifting travel.

2.3.3.3 Magnetic Control Equipment

The primary and accelerating contactors and/or static devices shall be mounted on one or more panels and shall be enclosed in a cabinet or cabinets. The control circuits shall be wired to terminal blocks or studs complete and ready for making all external connections. Insulated wire shall conform to the requirements of paragraph CONDUIT AND WIRING. Magnetic contactors for individual motor controls shall have a rating the equivalent of the motor controlled, but in no case shall a contactor less than NEMA size 1 be used. The protective panel main line contactor shall be rated in accordance with NEMA ICS 3 for Service Class I, except that in no case shall the rating be less than one NEMA size greater than the largest individual motor contactor used.

2.3.3.4 Control Panels

Control panels shall be fabricated of solid sheet steel designed and constructed to conform to the requirements of NEMA ICS 6 Type 4. Thermostatically controlled heaters shall be provided in each panel. Control panel doors shall be hinged, equipped with gaskets, and shall be fitted with key-lock handles designed to latch the door at top, center, and bottom. A single key shall open all locks.

2.3.3.5 Pendant Control Station

a. Design - The pendant control station shall be suspended from the crane by a strain chain or 6 mm (minimum) wire rope strain lead of corrosion resistant steel. The pendant station shall be attached to the underside of the crane gantry footwalkan . The pendant control station enclosure shall be NEMA Type 4 in accordance with NEMA ICS 6. Pushbuttons shall be heavy duty, dust-and-oil-tight type having distinctly felt operating positions. Pushbuttons shall be so constructed that they cannot become hung-up in the control case. Pendant shall include a separate set of pushbuttons for each motion and for POWER ON-POWER OFF. One yellow pilot light to indicate excessive hoist motor temperature shall be provided on the pendant station. A blue pilot light to indicate that the main contactor is energized and a white pilot light to indicate that power is available on the load side of the crane disconnect switch shall also be provided. The POWER OFF pushbutton shall have a bright red mushroom head. Operating pushbuttons and pilot lights shall meet the heavy-duty requirements of NEMA ICS 2. Pushbuttons shall be as follows:

Hoist - up
Hoist - down
Gantry- FORWARD
Gantry -REVERSE
Trolley - LEFT
Trolley - RIGHT
POWER OFF
POWER ON

b. Pendant Drive Control - three-position momentary contact spring return to OFF toggle switch shall be provided to control the motorized

trolley for the pendant.

c. Pendant Festoon System - The pendant festoon system shall consist of a support rail, flat cables, junction boxes, cable cars, and accessories. All hardware shall be corrosion resistant. Cable loops shall not drop below the hook high position. The pendant control car shall be provided with NEMA Type 4 junction box. The pendant festoon shall be independent of trolley motion.

d. Pendant Drive System - The pendant festoon system shall be provided with a motor drive system capable of driving the pendant control car at 100 . The pendant motor drive shall be controlled from the pendant.

e. Pendant Retraction System -The pendant control car shall be provided with an electric powered cable reel such that the pendant station may be retracted fully.

2.3.3.6 Protection

a. Main Line Disconnect - A main line disconnect consisting of a combination circuit breaker and nonreversing starter (main line contactor) in NEMA Type 4 enclosure shall be provided. The main line disconnect shall be controlled by a control circuit such that all crane motions shall be stopped upon main line undervoltage, overload, control circuit fuse failure, or operation of the POWER OFF pushbutton.

b. Circuit Breakers - Circuit breakers shall meet the requirements of UL 489 and NEMA AB 1.

c. Overloads -AC circuit overload relays shall be of the ambient compensated, automatic reset, inverse time type located in all phases of the main line and individual motor circuits and arranged to open the main line contactor.

2.3.3.7 Limit Switches

Limit switches shall be heavy duty quick-break double-pole double-throw type and shall conform to NEMA ICS 2. Geared limit switch interruption of a motion in one direction shall not prevent the opposite motion. Geared limit switches shall reset automatically. Limit switch housings shall be NEMA Type 4. Limit switches shall interrupt power to the control systems.

a. Hoist Upper Limit Switches - Two limit switches shall be provided for each hoist. A rotating adjustable geared control circuit interrupt limit switch shall provide hoist-up limiting. A secondary hoist upper limit shall be provided with a weight operated limit switch, to prevent raising beyond their safe limit. This secondary limit switch shall operate to interrupt power to all hoist motor conductors and set the hoist holding brakes.

b. Hoist Lower Limit Switches - Hoists shall be provided with a rotating adjustable geared control circuit interrupt limit switch for hoist-down travel limiting.

c. Gantry and Trolley Travel Limit Switches - Runway (track) limit switches shall be mounted to the crane gantry and trolley, respectively, adjacent to one runway rail to interrupt current to the gantry and trolley controls. Adjustable limit switch actuators shall

be installed on both ends of those rails to actuate the limit switches and stop the crane gantry or trolley prior to contacting the runway bumpers.

d. Rail Clamp Limit Switches - Each rail clamp shall be furnished with a limit switch designed to interrupt the control circuits to the gantry drive when the rail clamps are set. A red pilot light shall be provided at the control station to indicate the rail clamps are set.

2.3.3.8 Warning Horn

A solid state electronic warning horn shall be provided on the crane. Any gantry or trolley motion shall be accompanied by a continuous series of alternating tones.

2.3.3.9 Load Limit System

A load limit system shall be provided for the main hoist. The primary purpose of the load limit system is to inform the operator by an alarm that the preset load has been exceeded. The system shall consist of a load cell, load sensing electronics, no-load and overload indicator lights, overload alarm bell, and alarm cut-out switch. The load cell shall be mounted to receive the load from the axle of the equalizing sheave. The alarm setpoint shall be adjustable.

2.3.4 Motors

2.3.4.1 General Requirements

Motors shall be designed specifically for cranes and hoist duty. Drain holes shall be provided at low points near each end. Inspection and service covers shall be provided with gaskets. All hardware shall be corrosion resistant. Motors shall conform to the requirements of NFPA 70 and UL 1004. Motors shall be provided with a suitable heater to prevent condensation during long periods of inactivity. One thermal sensitive device embedded in the hoist motor windings shall be provided. The device and associated circuitry shall serve as an alarm activating a yellow pilot light at the control stations when motor temperatures become excessive. The set point shall be set below the Class B insulation temperature limit. The thermal-sensitive device and associated circuits shall be self-restoring (automatic reset).

2.3.4.2 Main Hoist Motor

The hoist motor shall be industrial single-speed; single-winding.

2.3.4.3 Gantry and Trolley Drive Motors

The gantry and trolley drive motors shall be industrialsingle-speed; single-winding wound rotor AC induction

2.3.4.4 Motor Enclosures

Motor enclosures shall be totally enclosed, fan cooled (TEFC).

2.3.4.5 Hoist Motor Insulation and Time Rating

The hoist motors shall be provided with Class B insulation with a 60-minute

minimum motor time rating to satisfy NEMA permissible motor temperature rise above 40 degrees C ambient permitted by Class B insulation.

2.3.4.6 Gantry and Trolley Motor Insulation and Tim e Rating

The gantry and trolley drive motors shall be provided with Class B insulation with a 60-minute minimum motor time rating to satisfy NEMA permissible motor temperature rise above 40 degrees C ambient permitted by Class B insulation.

2.3.5 Electric Brakes

2.3.5.1 Hoist Brake Time Delay

One of the hoist holding brakes shall be provided with a time delay setting (from 1 to 3 seconds). Such time delay shall be initiated upon release of the control pushbutton or return of the master switch to OFF.

2.3.5.2 Automatic Stop System

All electrically controlled brakes shall be applied automatically when power is interrupted. Brakes shall be wired so that the brakes release upon operation of a pushbutton for the associated drive and shall set upon release of that pushbutton, return of the master switch to OFF, operation of POWER OFF pushbutton, de-energization of main line contactor, or power failure. Electric brakes shall be designed so that they can be mechanically released. Enclosures for brake electrical components shall be NEMA ICS 6. DC shunt magnetic shoe brakes shall be provided with an electrical forcing circuit for rapid release of the brake. Each shunt coil brake shall be circuited so that both conductors supplying the brake are opened simultaneously when the brake is de-energized.

2.3.6 Lighting Heating and Convenience Outlets

Three-phase 208Y/120-volt AC power, supplied via a circuit breaker conforming with NEMA ST 1 from the line side of the main line disconnect shall be used for lightingheatersand accessory circuits on the crane. The circuit breaker shall have a NEMA 4 enclosure in accordance with NEMA ICS 6. The enclosure shall have provisions to lock the breaker in the OFF position. Each pole of the circuit breaker shall have individual thermal and magnetic trip elements; a button shall be provided on the enclosure cover for mechanically tripping the circuit breaker. A three-phase 480-volt delta primary, and 208Y/120-volt wye secondary general lighting isolation transformer shall be fed from the accessory circuit breaker and shall feed a 208Y/120-volt UL listed circuit breaker panelboard The panelboard shall supply branch circuits for utilization of various accessories such asreceptacleslighting and panel internal lighting.

2.3.6.1 Transformers

Transformers shall be dry type and shall carry full load continuously at rated voltage and frequency without exceeding an average temperature rise of 115 degrees C above an ambient temperature of 40 degrees C. The transformer shall have a totally enclosed case which shall be finished with manufacturer's standard coating system. Transformers shall be fully encapsulated, except for those specifically designed for use as an isolation transformer for static power conversion units.

2.3.6.2 Receptacles

Receptacles shall be, single-phase, 120-volt 15-amp, grounded, duplex with metal NEMA 4 enclosure with self-closing weather-proof receptacle cover. A receptacle shall be provided on each end of the gantry walkway, on the trolley, in the vicinity of gantry travel drive motors. Several receptacles shall be provided in the vicinity of the control equipment equally spaced every 1.5 m. Breakers used to protect circuits supplying receptacles shall incorporate ground fault current interruption feature and meet the requirements of UL 943.

2.3.6.3 Anticondensation Heaters

All motors and control panels shall be equipped with thermostatically controlled anticondensation heaters. The circuit breaker combination magnetic starter shall be NEMA 4enclosure in accordance with NEMA ICS 6. The magnetic starter shall be equipped with manually reset overload relays and shall be interlocked with the main line disconnect so that all anticondensation heaters are de-energized when the main line disconnect is energized; and shall be energized when the main line disconnect is de-energized.

2.3.7 Conduit and Wiring

2.3.7.1 General

All wiring between equipment units or components, except where flexible connections are specified, shall be installed in rigid, steel conduit with threaded condulet fittings and zinc-coated NEMA 4 outlet and pull boxes. Conduit connections to motors, brakes, limit switches, wheel trucks, and other items where flexible connections are required shall be made using short lengths of liquid-tight flexible conduit. The conduit shall be securely mounted and fastened to the crane framework and shall be installed in a neat and workmanlike manner. Change of direction of a conduit run shall be made by means of threaded condulet fittings and the conduit shall be installed to fit close to the crane framework. Conduit unions shall be used where standard couplings cannot be used to join conduits or as required to permit dismantling for shipment. No running threads will be permitted. Ends of conduits shall be carefully reamed.

All threaded connections shall be made up with a compound composed of colloidal copy and rust inhibitors. Separate conduit systems shall be provided for power, control, and lighting circuits. The entire conduit system shall be grounded and shall be installed so that any moisture will be drained from terminal boxes and equipment. All conduit connections to equipment enclosures shall be watertight threaded. Suitable "drain-breather" devices shall be provided at all low points of the conduit system to allow water to escape continuously. The conduit system shall be installed in the shop, complete and ready for installing wire and after inspection shall be dismantled as necessary for shipment to the site.

2.3.7.2 Conduit

a. Rigid Conduit - Rigid steel conduit shall conform to ANSI C80.1 and shall, in addition, be zinc-coated (galvanized) both inside and outside by the hot-dip method.

b. Flexible Conduit - Flexible conduit shall conform to CID A-A-55810,

shall have a hot-dipped galvanized steel core, copper ground wire, and a waterproof extruded PVC cover.

2.3.7.3 Insulated Wire and Cable

a. Materials, Construction and Tests - Materials, construction, and tests, unless otherwise specified, shall conform to the applicable requirements of NEMA WC 7 or NEMA WC 8, as applicable. Parts, tables, sections, appendices, grades, and classes specified will refer to the above NEMA standards, unless otherwise stated.

b. Conductors - Conductors shall be annealed copper wire. Copper conductors shall be tin or lead alloy coated, or bare, as required by the type of insulation used. All conductors shall have class B or C standing. Solid conductors will not be permitted.

c. Insulation

(1) Material

Insulation shall be a cross-linked polyethylene meeting the dimensional, electrical, and physical requirements of Part 3 of NEMA WC 7 or NEMA WC 8. Type I or Type II grade of EPR insulation shall be used for single-conductor cables with a jacket and for the individual conductors of a multiple-conductor cable with an overall jacket.

(2) Insulation Thickness

Insulation thickness shall be as required by Table 3-1, Part 3 of NEMA WC 7 or NEMA WC 8 as applicable, for rated circuit voltage of 0-600 volts. Single-conductor cross-linked polyethylene insulated cables with Column A thickness only will be permitted without a jacket. Single-conductor ethylene-propylene-rubber insulated conductors with Column A thickness will not be permitted.

d. Type - Unless otherwise specified or approved, all wire and cable for power, control, and lighting shall be single conductor.

e. Jackets - An outer jacket of a synthetic thermosetting material shall be applied over multiple-conductor cables. Single-conductor cables and individual conductors of a multiple-conductor cable may have a jacket. The jacket shall be tightly and concentrically formed around the core of the cable. Single-conductor cables shall have jackets when insulation thickness is in accordance with Column B, Table 3-1, Part 3 of NEMA WC 7 or NEMA WC 8. The jacket shall be a synthetic thermosetting compound and shall conform to one of the following:

(1) Heavy-duty black neoprene in accordance with paragraph 4.4.3 of NEMA WC 8.

(2) Heavy-duty black chlorosulfonated polyethylene in accordance with paragraph 4.4.9 of NEMA WC 8.

f. Dimensional Tolerance - The outside diameter of single-conductor wires and cables shall not vary more than 5 percent from the calculated outside diameter based on the thickness, including tolerance, of the component materials specified.

g. Wires - Near resistors, wiring exposed to heat shall have flame retardant, heat and moisture resistant insulation, and conform to the requirements of NFPA 70 and the following: Maximum operating temperature for conductors generally shall be 90 degrees C except that maximum operating temperature for internal wiring conductors in resistor cabinets shall be 125 degrees C.

h. Control Panel Wiring - Control panel wiring shall be stranded copper switchboard wire with 600-volt insulation and except for type SIS shall be coated. The wire shall be AVB or SIS. Hinge wire shall have Class K stranding. Hinge wire shall be used between stationary and hinged equipment and shall be formed in wire loops or bundles at least 600 mm long which shall provide rotation around the longitudinal axis of the conductors.

i. Festoon System Cable - The connections to the trolley shall be made using type G cables with 75 degrees C, 600-volt insulation and heavy-duty "Neoprene" jacket for the power circuits and type SO cord with 60 degrees C, 600-volt insulation and "Neoprene" jacket for control and lighting circuits. Type G cables and SO cords shall conform to the applicable requirements of NEMA WC 3, Part 7, paragraphs 7.6 and 7.7, respectively. Conductors shall have not less than class H stranding.

j. Current Carrying Capacity - Wire for power and motor circuits shall have a current carrying capacity of not less than the full-load current of the motor or the circuit but in no case less than No. 10 AWG. Wire for control circuits shall not be smaller than No. 14 AWG. Wires exposed to heat or in resistor cabinets shall be sized as required but in no case less than No. 10 AWG.

k. Terminations and Continuity - All conductor connections, except for splices in lighting conductors which are made in junction boxes, shall be terminated at terminal studs or terminal blocks using approved indented terminal ring-tongue connectors. All screw terminals shall have lockwashers and all stud terminals shall have contact nuts and either locking nuts or lock washers. Splices will be permitted only in accordance with NFPA 70.

PART 3 EXECUTION

3.1 SHOP ASSEMBLY AND TESTS

The hoists, trolleys, trolley drives, and gantry drives shall be shop assembled and operated under their own power. Reeving of drums and sheaves will not be required. Permanent wiring except wire which would be disassembled or partly disassembled for shipment shall be installed. Permanent conduit except conduit attached to walkways, ladders, stairs, and machinery housing shall be installed. The gantry structural frame shall be assembled and checked for fit and alignment. The test shall demonstrate that the various parts and components are correctly fabricated, assembled, and fitted. The Contractor shall notify the Contracting Officer 15 days prior to testing operations.

3.2 PREPARATION FOR SHIPMENT

After completion of the shop tests, the crane shall be match-marked and

prepared for shipment with electrical connections tagged. Four copies of a diagram of match-marks shall be furnished. All parts and equipment at the site shall be protected from weather, damage, abuse, and loss of identification.

3.3 ERECTION

Erection shall be in accordance with the manufacturer's instructions. **(AM#1)**

3.3.1 Erection Procedures

Major components of the crane shall be shop assembled as completely as possible. The erection procedures shall ensure that the crane is erected without initial stresses, forced or improvised fits, misalignments, nicks of high-strength structural steel components, stress-raising welds, and rough burrs. After the crane is erected, any damaged painted surfaces shall be cleaned and repainted. After erection is complete, the equipment shall be serviced. All necessary grease and oil of approved quality and grade for the initial servicing and field test shall be provided by the Contractor.

3.3.2 Mechanical Alignment

All motors, couplings, brakes gear boxes, and drive components shall be aligned when reinstalled, in accordance with manufacturer's instructions.

3.3.3 Electrical Alignment

The control system shall be aligned in accordance with manufacturer's instructions. Alignment data shall include timer settings, resistor tap settings, potentiometer settings, test point voltages, supply voltages, motor voltages, motor currents, and test conditions such as ambient temperature, motor load, date performed, and person performing the alignment. A copy of the final alignment data shall be stored in control panel door.

3.4 ACCEPTANCE TESTING

3.4.1 Crane Test

The Contractor shall provide all personnel necessary to conduct the tests including but not limited to crane operators, riggers, rigging gear, and test weights. Testing shall be performed in the presence of Contracting Officer. The Contractor shall notify the Contracting Officer 15 days prior to testing operations.

3.4.1.1 Test Sequence

The crane shall be tested according to the applicable paragraphs of this procedure in the sequence provided.

3.4.1.2 Test Data

Operating and startup current measurements shall be recorded for electrical equipment (motors and coils) using appropriate instrumentation. Speed measurements shall be recorded as required by the facility evaluation tests (normally at 100 percent load). Recorded values shall be compared with

design specifications or manufacturer's recommended values; abnormal differences shall be explained in the remarks and submitted for approval or appropriate adjustments performed. In addition, high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated, and corrected. Hoist, trolley, and gantry speeds should be recorded during each test cycle.

3.4.1.3 Equipment Monitoring

During the load test, improper operation or poor condition of safety devices, electrical components, mechanical equipment, and structural assemblies shall be monitored. Observed defects critical to continued testing shall be reported immediately to the Contracting Officer, and testing shall be suspended until the deficiency is corrected. During and immediately following each load test, the following inspections shall be made:

a. Inspect for evidence of bending, warping, permanent deformation, cracking, or malfunction of structural components.

b. Inspect for evidence of slippage in wire rope sockets and fittings.

c. Check for overheating in brake operation; check for proper stopping. All safety devices, including emergency stop switches and POWER OFF pushbuttons, shall be tested and inspected separately to verify proper operation of the brakes.

d. Check for abnormal noise or vibration and overheating in machinery drive components.

e. Check wire rope sheaves and drum spooling for proper operation, freedom of movement, abnormal noise, or vibration.

f. Check electrical drive components for proper operation, freedom from chatter, noise, or overheating.

g. Inspect external gears for abnormal wear patterns, damage, or inadequate lubrication.

3.4.1.4 Hooks

Hooks shall be measured for hook throat spread before and after load test. A throat dimension base measurement shall be established by installing two tram points and measuring the distance between these tram points (to within 0.4 mm). This base dimension shall be recorded. The distance between tram points shall be measured before and after load test. An increase in the throat opening by more than 1 percent from the base measurement shall be cause for rejection.

3.4.2 No-Load Testing

3.4.2.1 Hoist Operating and Limit Switch Test

The load hook shall be raised and lowered through the full range of normal travel at rated speed and other speeds of the crane. The load hook shall be stopped below the geared limit switch upper setting. In slow speed only, proper operation of upper and lower limit switches shall be verified. The test shall be repeated a sufficient number of times (minimum of three)

to demonstrate proper operation. Brake action shall be tested in each direction. The proper time delay shall be verified between the actuation of the dual brakes.

3.4.2.2 Trolley Travel

The trolley shall be operated the full distance of the gantryrails exercising all drive speed controls in each direction. Brake operation shall be verified in each direction. In slow speed the trolley bumpers shall contact the trolley stops located on the gantrygirders.

3.4.2.3 Gantry Travel

The gantry shall be operated the full distance of the runway exercising all drive speed controls, in each direction. Brake operation shall be verified in each direction. In slow speed, the proper operation (interrupt power, automatic reset) of the gantry limit switches at both limits of gantry motion shall be tested. In slow speed, the crane gantry bumpers shall contact the runway rail stops.

3.4.2.4 Hoist Loss of Power No-Load Test

The hooks shall be raised to a height of approximately 3.5 m or less. While slowly lowering the hook, the main power source shall be disconnected verifying that the hook will not lower and that both brakes will set.

3.4.2.5 Travel Loss of Power No-Load Test

With the hook raised to clear obstructions and the trolley traveling in slow speed, the main power source shall be disconnected verifying that the trolley will stop and that the brake will set. The test shall be repeated for the gantry slow speed drive controls.

3.4.3 Load Test

3.4.3.1 Hoist

Unless otherwise indicated, the following tests shall be performed using a test load of 125 percent of rated load.

a. Hoist Static Load Test: Holding brakes and hoisting components shall be tested by raising the test load approximately 900 mm and manually releasing one of the holding brakes. The load shall be held for 10 minutes. The first holding brake shall be reapplied and the second holding brake released. The load shall be held for 10 minutes. Any lowering that may occur indicates a malfunction of the brakes or lowering components.

b. Dynamic Load Test: The test load shall be raised and lowered at each speed through the full operating range. The machinery shall be completely stopped at least once in each direction to ensure proper brake operation.

c. Hoist Load Brake: With test load raised approximately 1.5 m and with the hoist controller in the neutral position, the holding brake shall be released. The load brake shall be capable of holding the test load. With the holding brake in the released position, the test load shall be lowered (first point) and the controller shall be returned to

OFF position as the test load lowers. The load brake shall prevent the test load from accelerating.

d. Hoist Loss of Power Test: After raising the test load to approximately 2.5 m, begin slowly lowering the test load, the main power source and the control pushbutton shall be released verifying that the test load will not lower and that both brakes will set.

e. Trolley Dynamic Load Test: While operating the trolley the full distance of the gantry rails in each direction with test load on the hook (one cycle), the proper function of all speed control points and proper brake action shall be tested.

f. Gantry Dynamic Load Test: With test load on the hook, the gantry shall be operated for the full length of the runway in both directions with the trolley at each extreme end of the gantry. Proper function of all drive speed control points and brake action shall be verified. Binding of the gantry end trucks shall indicate malfunction.

3.4.3.2 Trolley and Gantry Loss of Power Test

Using a test load of 100 percent of rated load, the load shall be raised clear of any obstructions on the operating floor. Starting at a safe distance from walls or other obstructions, a slow speed shall be selected using the trolley and gantry drive. While maintaining a safe distance to obstructions, the main power source shall be disconnected and the brakes shall be verified to have set and that the equipment stops within the distance recommended by the manufacturer.

3.5 FRAMED INSTRUCTIONS

Framed instructions under acrylic plastic or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

3.6 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, erection, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.7 FIELD TRAINING

A field training course shall be provided for designated operating staff members. Training shall be provided for a total period of 8 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions. The Contracting Officer shall be given at least 2 weeks advance notice of such training.

3.8 SPARE PARTS

One set of manufacturer's recommended spare parts shall be furnished and delivered to the site. The spare parts shall be suitably packaged for long-term protection and storage. The packaging shall be legibly labeled to identify the spare parts. A list of the furnished spare parts shall be included in the Maintenance manual.

-- End of Section --